NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

USN/USMC Antiair Warfare and Command, Control, and Communications for Amphibious Operations

by

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March 1992

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b OFFICE SYMBOL (*If applicable*) 39	7a NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c. ADDRESS (*City, State, and ZIP Code*) Monterey, CA 93943-5000	7b ADDRESS (*City, State, and ZIP Code*) Monterey, CA 93943-5000
8a NAME OF FUNDING/SPONSORING ORGANIZATION 8b OFFICE SYMBOL (*If applicable*)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (*City, State, and ZIP Code*)	10 SOURCE OF FUNDING NUMBERS Program Element No / Project No / Task No / Work Unit Accession Number

11 TITLE (*Include Security Classification*)
USN/USMC Antiair Warfare and Command, Control, and Communications for Amphibious Operations

12 PERSONAL AUTHOR(S) Edward A. Yeaste and Gilbert C. Gonzalez

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (*year, month, day*)	15 PAGE COUNT
Master's Thesis	From To	March 1992	182

16 SUPPLEMENTARY NOTATION
The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

17 COSATI CODES

FIELD	GROUP	SUBGROUP

18 SUBJECT TERMS (*continue on reverse if necessary and identify by block number*)
Command and Control, Command and Control Systems, C2 Process, C3, NTDS, TAOM, CWC, C3 Systems, Joint Chiefs of Staff, Unified and Specified Commands, AOA, MACCS, Amphibious Operations, Data Links, AAW, AAW Weapon Systems, AAW Principles

19 ABSTRACT (*continue on reverse if necessary and identify by block number*)

There is currently no single document that aids a Joint Force Commander or their staff in understanding the complexities of Antiair Warfare (AAW) during amphibious operations by maritime forces. Historically, the Navy has been concerned with the Outer Air Battle. This involves vast distances over the ocean, but does not cover amphibious operations. With the down sizing of the U.S. military as a result of an end to the "Cold War", there will be fewer overseas bases and assets to conduct contingency amphibious operations. The authors review the current and future Command, Control, and Communication (C3) capabilities of the U.S. Navy and U.S. Marine Corps for AAW during amphibious operations. The authors propose that the Amphibious Defense Zone Coordinator (ADZC) paradigm be accepted so that an integrated air defense of the Amphibious Ojective Area (AOA) and the Carrier Battle Group (CVBG) are treated as subsets of the same overall plan

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT [X] UNCLASSIFIED/UNLIMITED [ ] SAME AS REPORT [ ] DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL LCDR William J. Walsh	22b TELEPHONE (*Include Area code*) (408) 646-3113 22c OFFICE SYMBOL OR/WA

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

Approved for public release; distribution is unlimited.

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Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY
(Command, Control, and Communications)

from the

NAVAL POSTGRADUATE SCHOOL
March 1992

ABSTRACT

There is currently no single document that aids a Joint Task Force Commander or their staff in understanding the complexities of Anitair Warfar (AAW) during amphibious operations by maritime forces. Historically, the Navy has been concerned with the Outer Air Battle. This involves vast distances over the ocean, but does not cover amphibious operations. With the down sizing of the U.S. military as a result of an end to the "Cold War", there will be fewer overseas bases and assets to conduct contingency amphibious operations. The authors review the current and future concepts and doctrine, Command, Control, and Communications, and weapon systems of the U.S. Navy and Marine Corps for AAW during amphibious operations. The authors propose that the Amphibious Defense Zone Coordinator (ADZC) paradigm be accepted so that an integrated air defense of the Amphibious Objective Area (AOA) and the Carrier Battle Group (CVBG) are treated as subsets of the same overall AAW plan.

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I. INTRODUCTION

A. BACKGROUND

This paper will bring to light some of the Command, Control and Communications (C^3) problems in Antiair Warfare (AAW) during amphibious operations by the United States Navy (USN) and Marine Corps. The AAW doctrine for the USN since the end of World War II (WW II) has been oriented towards the defense of the Carrier Battle Group (CVBG). The current version of this doctrine is known as the Outer Air Battle (OAB). The OAB doctrine provides for tactics and procedures that provide a layered defense emanating from the carrier and her escorts out to approximately 500 nm. This doctrine was designed specifically to defeat attack by large numbers of Antiship Missile (ASM) carrying bombers of the Soviet Union. With the fall of the Soviet Union in the early 1990's and the break up of its armed forces to the various independent states formed from the former Soviet Union, the threat that this doctrine was created for no longer exists.

The threat of third world disorder and possible armed conflicts arising from these corners of the world appear to be taking a much more important role in adversely affecting our national interests. Although conflicts of this nature have been of a continuing nature since WW II, they seem to have

always been overcome by the threat of the Soviet Union and her capabilities to wage war. As a result, the Navy and Marine Corps have developed a doctrine that counters the various threats of the Soviet Union assuming that it would also be capable of countering third world threats by default. A brief look at the past 13 years leads to debate whether that assumption is true or not.

- 1979 Iran hostages (Operation EAGLE CLAW)
- 1983 Grenada (Operation URGENT FURY)
- 1986 Libya (Operation ELDORADO CANYON)
- 1988 Persian Gulf (Operation PRAYING MANTIS)
- 1989 Panama (Operation JUST CAUSE)
- 1990 Iraq (Operations DESERT SHIELD)
- 1991 Iraq (Operation DESERT STORM)

If one were to include all the Non-combatant Evacuation Operations (NEOs) conducted by the Navy and Marines during the same period, the list would be appreciably longer. "A historical analysis of the facts shows that, of over 200 regional crises that naval forces responded to between 1945 and 1989, only 18 directly involved the Soviets" [Ref. 1:p. 13]

The procedures for conducting an amphibious operation have been well established since WW II. The purpose of this thesis is to provide its readers a basic understanding of the

complexity of joint Navy and Marine Corps AAW in support of amphibious operations.

This thesis will cover the basic principles of planning and conducting an amphibious operation; discuss the current and possible future doctrine and procedures for providing the air defense of an amphibious force; describe in detail current and future Command, Control and Communication (C^3) systems that could conduct the air battle; describe the capabilities of current and future weapon systems for AAW in amphibious operations; and finally provide the authors' recommendations and conclusions on conducting AAW during amphibious operations.

Two proposals have been made to change amphibious doctrine to obtain a more integrated Battle Force. Commander Third Fleet (COMTHIRDFLT) proposes making the Commander Amphibious Task Force (CATF) a separate warfare commander under the Officer-in-Tactical Command (OTC) so as to integrate the Battle Force into a single Composite Warfare Commander (CWC) organization. Commander Surface Warfare Development Group (CSWDG) proposes combining the functions of the CATF's and Carrier Battle Group's (CVBG's) Antiair Warfare Commanders (AAWCs) into a an single integrated organization. The authors propose that the Amphibious Defense Zone Coordinator (ADZC) paradigm be accepted so that an integrated air defense of the

Amphibious Objective Area (AOA) and the CVBG are treated as subsets of the same overall AAW plan.

B. ORGANIZATION

The thesis is organized into chapters that discuss or analyze a specific aspect of AAW. Chapter I serves as an introduction providing a background.

Chapter II serves as a prelude into the subject of AAW by defining terms, processes and command relationships associated with AAW. A clear understanding of these definitions facilitates the discussion of AAW during amphibious operations.

Chapter III discusses the present way the Navy and Marine Corps conduct AAW in support of amphibious operations. It starts off by defining the various Commanders in Chief. The present Navy and Marine Corps command organization, including a description of each subordinate commander and his function, is discussed. This is done in order to highlight the principal players and their interrelationships during the conduct of AAW in support of amphibious operations. The present doctrine in the form of AAW principles is discussed separately for both the Navy and Marine Corps. This is done in order to review the present doctrine for each service and possibly expose any major deficiencies or differences when conducting AAW in support of amphibious operations.

Chapter IV discusses the current Command, Control, and Communication (C^3) systems that are presently in use by the Navy and Marine Corps. A brief description of the major C^3 systems employed by each service is provided. This highlights system capabilities and exposes interoperability issues.

Chapter V provides the current weapon systems that are available to the Navy and Marine Corps that could be employed to conduct AAW in support of amphibious operations. This is done in order to expose weapon systems capabilities and vulnerabilities. It is hoped that this information may aid a commander in effectively integrating all his AAW assets and best employ them by exploiting their capabilities and minimizing their limitations.

Chapter VI discusses future concepts and doctrine. There are several doctrinal changes that are being proposed for future operations. These proposals are reviewed in order to compare them to present doctrine and to provide an evaluation as to whether they are viable principles to be integrated into future operations.

Chapter VII discusses future C^3 systems. This will provide insight into future C^3 capabilities and limitations of the Navy and Marine Corps.

Chapter VIII provides a description of future weapon systems that may be employed in the conduct of AAW during

amphibious operations. The chapter focuses on systems that have been started in the weapons procurement cycle and ones which the authors feel will be continued and available in the near future. Existing systems and their enhanced capabilities are highlighted.

Chapter IX provides a short summary and the authors' conclusions.

II. BACKGROUND

A. COMMAND

As with any military operation that is to be successful, there must be clear lines of command. However, with the US military there are several different levels of command. The ultimate military commander in the US is the President. He is supported in this area of responsibility by the Secretary of Defense. Together, they are known as the National Command Authorities (NCA). Since it is impossible for them to be everywhere at once, there are specific procedures to establish a clear line of command from the military operation back to the NCA. [Ref. 2:pp. 51-52]

1. Joint Chiefs of Staff (JCS)

The Joint Chiefs of Staff (JCS) assist the NCA in exercising direction over the Unified and Specified Commands (USCs). This assistance is to a degree determined by the NCA. One of the ways the JCS assists is by publishing joint publications. These publications set forth principles, doctrines, and military guidance to govern the joint activities and performance of the Armed Forces of the US [Ref. 3:p. 1]. As a result, the JCS has produced several definitions of key military terms so that the USCs have a common language. It is important to have a keen a

understanding of the key military terms involved with an amphibious operation.

2. JCS Definition of Command

> Command - The authority that a commander in the military Service lawfully exercises over subordinates by virtue of rank or assignment. Command includes the authority and responsibility for effectively using available resources and for planning the employment of, organizing, directing, coordinating, and controlling military forces for the accomplishment of assigned missions. It also includes responsibility for health, welfare, morale, and discipline of assigned personnel. [Ref. 4:p. 77]

a. *Combatant Command (COCOM)*

The Combatant Commander has non-transferable command authority known as Combatant Command, which is set forth in title 10, United States Code and is exercised only by combatant USCs. This provides full authority to organize and employ commands and forces as the Commander-in-Chief of a combatant USC considers necessary to accomplish the assigned missions. The Combatant Commander normally exercises his authority through subordinate commanders which are usually Service component commanders. [Ref. 4:p. 73]

B. CONTROL

Control becomes a very important factor concerning actual engagement of military forces. As we can see from the various levels of command listed above, there are also several layers and types of control. In order to conduct an organized military operation, all involved must understand the abilities

of different commands to control particular units and the type of control they have over those units.

1. JCS Definition of Control

Control - Authority which may be less than full command exercised by a commander over part of the activities of subordinate or other organizations. [Ref. 4:p. 88]

a. Operational Control (OPCON)

Operational control - Transferable command authority which may be exercised by commanders at any echelon at or below the level of combatant command. Operational control is inherent in Combatant Command (command authority) and is the authority to perform those functions of command over subordinate forces involving organizing and employing commands and forces, assigning tasks, designating objectives, and giving authoritative direction necessary to accomplish the mission. [Ref. 4:pp. 262-263]

b. Tactical Control (TACON)

Tactical control - The detailed and, usually, local direction and control of movements or maneuvers necessary to accomplish missions or tasks assigned. [Ref. 4:p. 361]

c. Centralized Control

Centralized control - In air defence, the control mode whereby a higher echelon makes direct target assignments to fire units. [Ref. 4:p. 63]

d. Decentralized Control

Decentralized control - In air defense, the normal mode whereby a higher echelon monitors unit actions, making direct target assignments to units only when necessary to insure proper fire distribution or to prevent engagement of friendly aircraft. [Ref. 4:p. 104]

C. COMMAND AND CONTROL (C^2)

The purpose of command and control throughout the various levels, is to ensure that the desires of the commander are carried out by their subordinate commanders. This process

flows down the chain of command until it reaches the area of operation where the desires are executed. The process is carried out "through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander." [Ref. 4:p. 77]

1. JCS Definition of Command and Control

> Command and control - The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. [Ref. 4:p. 77]

2. JCS Definition of Command and Control System

> Command and control system - The facilities, equipment, communications, procedures, and personnel essential to a commander for planning, directing, and controlling operations of assigned forces pursuant to the missions assigned. [Ref. 4:p. 77]

D. COMMAND, CONTROL AND COMMUNICATIONS (C^3)

In an effort to more accurately describe the process that a commander uses to enact his desires on the battlefield, the term Command, Control and Communications was developed. It is hard to find a definition for C^3. JCS has not established a definition for it. The reason for this may be that several people believe that C^3 does not accurately describe the process. Many believe that it should be Command, Control, Communications, and Intelligence (C^3I) to indicate the vital role that intelligence plays in the process. Others believe it should be Command, Control, Communications, Computers, and Intelligence (C^4I) to bring in the importance that computers

now play in relaying, displaying and calculating tactical data in the process. Advocates of information systems believe the term should be Command, Control, Communications, Computers, Intelligence, and Information (C^4I^2) to emphasis the transfer of data throughout the process. There are even those that believe that it should be C^mI^n to show that there are an infinite number of factors that go into the process. [Ref. 5:pp. 23-24]

In reality, "A rose is but a rose by any other name." No matter what acronym you want to use to describe the process that the system executes, the process remains the same. We will use the term C^3 for describing the process.

1. The C^3 System

The C^3 system is the most important factor in the process. It must be a system that supports a process that is known by all that use it. The system is really a number of different systems tied together by several different means with the goal of accomplishing the process within the requirements established by the commander. All C^3 systems, no matter what their process, have several traits.

- Flexibility
- Reliability
- Responsiveness
- Interoperability
- Survivability

- User friendliness [Ref. 2:p. 25]

2. The "OODA Loop" and the Process

The Observe, Orient, Decide and Act (OODA) Loop was designed by Mr. John Boyd to provide a generic description of the process of a commander ensuring that his desires are enacted by his subordinates (See Figure 1).

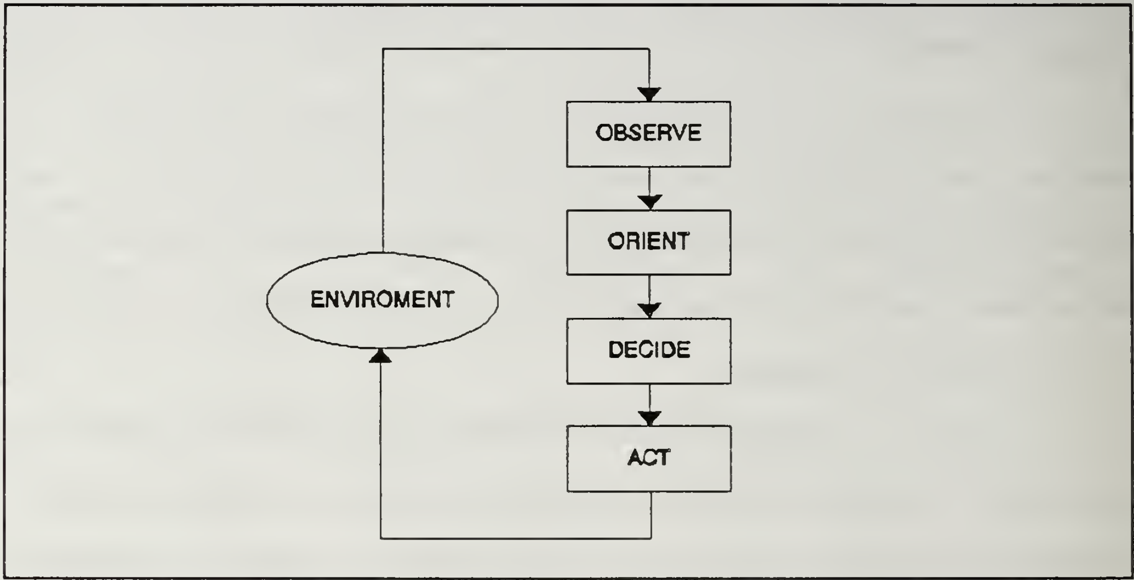


Figure 1 The OODA Loop [Ref. 5:p. 26]

It is important to remember that this is a generic description. Anyone examining a specific system and its process could get much more detailed in its description. It is also necessary to realize that it is a continuous process. We will follow the OODA Loop through an AAW C^3 system. [Ref. 5:p. 26]

a. Observe

To start the process, one must observe an object in the environment for which the system was designed. In AAW this is commonly done with an air search radar detecting an air target. The means of detection, however, is not critical. Any method that the system recognizes is valid. Once the observance is made, we move to the next part of the process. [Ref. 5:pp. 26-28]

b. Orient

Once an observance in the environment is made, information from the observance must be oriented within the system. In other words, the detection of an air target must be relayed throughout the system. This is probably the hardest job of the system. The data must get to those that need it, but should not impede other operations within the system. This is also where the commander sets his requirements within the system for facilities, equipment, communications, procedures, personnel, plans, and directions for controlling the system's process. For the AAW arena, this might involve a picket detecting a new air track, the information from that detection relayed to the C^3 system where it is analyzed. If not already being tracked within the system, it will be given a force track number and distributed to the rest of the system. [Ref. 5:pp. 26-28]

c. Decide

The decision to be made by the commander may be influenced by the accuracy and timeliness of the C^3 system. He does, however, make the decision and then must convey that decision or desire through the system to the subordinate units. This may be the decision by the commander for the radar picket to engage the newly detected track because he has determined (with information from within or outside the system) that it is hostile. The system relays this decision to the picket. [Ref. 5:p. 31]

d. Act

Once the commander has made a decision to perform a particular task, it remains the responsibility of that subordinate commander to execute the order. This would involve the radar pickets weapon systems being activated by the picket's commander to fire an AAW weapon to destroy the target that has been designated as a hostile air track. [Ref. 5:p. 29]

e. Environment

Once an order has been acted upon, the results of that action and how it has effected the environment must be reported back to the commander. This might be a feedback report from the system that a missile was launched against the hostile track and it was successful in its engagement. [Ref. 5:pp. 24-26]

E. AMPHIBIOUS OPERATIONS

1. Initiating Directive

This is the order given by the unified commander, subunified commander, service component commander, or Joint Force Commander to the Commander Amphibious Task Force (CATF) to conduct an amphibious operation. It establishes the Amphibious Task Force (ATF), defines the Amphibious Objective Area (AOA), assigns a mission and designates the CATF, Commander Landing Force (CLF) and other commanders as appropriate. It also provides special instructions on command relationships and instructions for the conduct of supporting operations. [Ref. 6:p. II-2]

2. Purpose

The primary purpose of an amphibious operation is to establish a Landing Force (LF) on a hostile or potentially hostile shore. This must be done quickly and with overwhelming combat power in order to accomplish the mission.

The goal of the amphibious operation is to obtain a site for an advanced naval, land or air base, deny the use of an area or facilities to the enemy and prosecute further combat operations. [Ref. 6:p. I-1]

3. Types

a. Amphibious Assault

The Assault is the principal type of amphibious operation which involves establishing a force on a hostile

shore. The amphibious assault requires building up combat power ashore from an initial zero capability to an effective striking force. [Ref. 4:p. 26]

b. Amphibious Demonstration

The Demonstration is conducted for the purpose of deceiving the enemy by a show of force. This action can disrupt, delay or cause the enemy to select a course of action which may be unfavorable to him. [Ref. 4:p.27]

c. Amphibious Raid

The Raid involves a swift incursion into an objective area for the purpose of a temporary occupation. The Raid is followed by a planned withdrawal. [Ref. 4:p.27]

d. Amphibious Withdrawal

The Withdrawal involves extracting forces by sea in naval ships or craft from a hostile or potentially hostile shore. [Ref. 4:p. 28]

4. Sequence of Operations

a. Planning

This phase extends from the issuance of the initiating directive to embarkation. It is important to note that planning is a dynamic on going process and does not end until the mission is complete. [Ref. 67:p. I-7]

b. Embarkation

This is the period in which forces, equipment and supplies embark on designated ships. [Ref. 6:p. I-7]

c. Rehearsal

This is the period in which plans and communications are tested to ensure all echelons are familiar with the plans. [Ref. 6:p. I-7]

d. Movement

This is the period when forces from the ATF move from embarkation areas to the AOA. This phase is completed when the forces arrive at their designated areas within the AOA. [Ref. 6:p. I-7]

e. Assault

This period commences when the assault forces of the ATF arrive in the Amphibious Objective Area (AOA) and continues until the accomplishment of the ATF mission. [Ref. 6:p. I-7]

F. ANTIAIR WARFARE (AAW)

> AAW is the action required to destroy or reduce to an acceptable level, the enemy air and missile threat. It includes such measures as the use of interceptors, bombers, antiaircraft guns, surface to air and air to air missiles, electronic countermeasures, and destruction of the air or missile threat both before and after it is launched. Other measures which are taken to minimize the effects of hostile air action are cover, concealment, dispersion, deception (including electronic), and mobility. [Ref. 4:p. 29]

AAW's goal is to gain and maintain air superiority which is necessary for a successful amphibious operation.

1. Air Superiority

Air superiority is the degree of dominance in the air battle of one force over another which permits the conduct of operations by its component land, sea and air forces at a given time and place without prohibitive interference by the opposing force. [Ref. 4:p. 21]

2. Air defense

Air defense is all defensive measures designed to destroy attacking enemy aircraft or missiles or to nullify or reduce the effectiveness of such attack. [Ref. 4:p. 14]

a. Active air defense

> Active air defense is direct defensive action taken to destroy attacking enemy aircraft or missiles or to nullify or reduce the effectiveness of such attack. It includes such measures as the use of aircraft, interceptor missiles, air defense artillery, weapons not used primarily in an air defense role, and electronic warfare. [Ref. 4:p. 3]

b. Passive air defense

> Passive air defense constitutes all measures, other than active defense, taken to minimize the effects of hostile air action. These include the use of cover, concealment, camouflage, deception, dispersion, and protective construction. [Ref. 4:p. 272]

3. Offensive AAW

> Offensive AAW constitutes operations conducted against the enemy air or air defense system before it can be launched or assume an attacking role. Offensive AAW operations in or near the objective area consist mainly of air attacks to destroy or neutralize hostile aircraft, airfields, radars, air defense systems, and supporting areas. [Ref. 7:p. 1-1]

G. SUMMARY

It is essential to establish a fundamental understanding of the terms and processes that are associated with AAW in order to comprehend such a complex warfare. Chapter III describes Navy and Marine Corps organization and command and desribes the current doctrine in the form of principles used by the Navy and Marine Corps to conduct AAW.

III. CURRENT COMMAND CONCEPTS AND DOCTRINE

A. JOINT ORGANIZATION AND COMMAND

All military operations conducted by unified Combatant Commands are of a joint nature whether it is readily recognizable or not. An amphibious operation may seem to be primarily a Navy/Marine Corps operation, but there is definitely a joint chain of command to the officer placed in charge of the operation (See Figure 2).

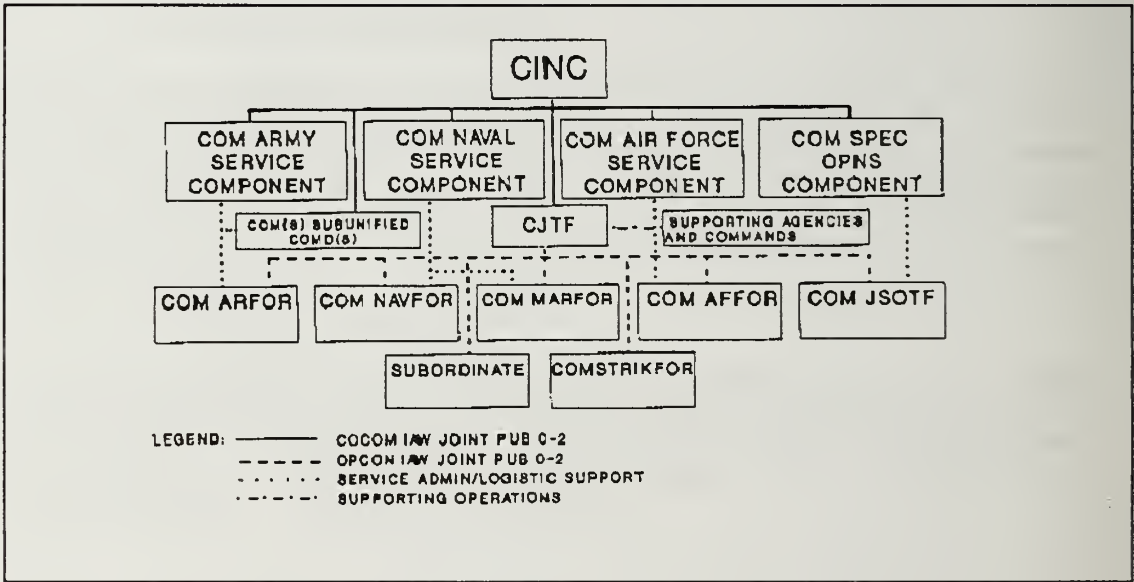


Figure 2 Joint Organization [Ref. 9:p. II-6]

1. Commander-in-Chief (CINC)

The Commander-in-Chief is the officer that has been placed in command of a unified or specified command. Unified commands are responsible for specific geographical regions of

the world and have components from each armed service. The specified commands have a broad and continuing mission established by the President and are composed of but one armed service. Only the unified Combatant Commands are capable of conducting amphibious operations on foreign soil. As of December 1991, there are eight unified commands within the US military organization:

- U.S. Space Command (CINCSPACECOM);
- U.S. Special Operations Command (CINCSOCOM);
- U.S. Transportation Command (CINCTRANSCOM);
- U.S. Pacific Command (CINCPACOM);
- U.S. Atlantic Command (CINCLANTCOM);
- U.S. European Command (CINCEUCOM);
- U.S. Central Command (CINCCENTCOM);
- U.S. Southern Command (CINCSOUTHCOM). [Ref. 2:pp. 36-49]

The first three unified commands listed are supporting commands. They themselves would not be responsible for an amphibious operation, but would provide support to the other five unified commands in their particular area of responsibility. The last five unified commands are considered combatant unified commands. The two specified commands, Strategic Air Command and Forces Command, would also provide support if requested by the unified Combatant Command conducting the operation. [Ref. 2:p. 36-49]

2. Commander-in-Chief Naval Forces (CINCNAV)

This is the senior officer of the USN assigned to the CINC and is responsible to him for all naval forces assigned to that unified command. He is also known as the component commander. Any additional naval forces assigned to the CINC for the conduct of the operation would chop to the Operational Control (OPCON) of the CINCNAV for that CINC. CINCNAV would normally transfer OPCON of participating units to the Commander Naval Force (COMNAVFOR) assigned to the Joint Force Commander (JFC). [Ref. 8:p. 2-7 - 2-10]

3. Commander-in-Chief Air Forces (CINCAF)

This is the Air Force officer assigned to the CINC that is responsible for all Air Force units assigned to that unified command. All Air Force commands participating in an amphibious assault would be under this component commander's OPCON. If the Joint Forces Air Component Commander (JFACC) is not an Air Force officer, CINCAF would liaison directly with the JFACC to ensure that the JFACC receives the support required to accomplish the mission. [Ref. 8:p. 2-11 - 2-14]

4. Commander-in-Chief Army Forces (CINCAR)

Although there would normally be few Army forces involved in an amphibious operation, those that were would be under CINCAR's command. If the amphibious operation is of an extraordinarily large nature the likelihood of Army forces being used increases greatly. It is possible for the

Commander, Landing Force (CLF) to be an Army officer if the majority of the assault forces are from the Army. [Ref. 8:p. 2-4 - 2-7]

5. Commander-in-Chief Marine Forces (CINCMAR)

As one would think, CINCMAR for the unified command would be a key component commander for an amphibious operation. He would be responsible for ensuring that there were enough Marine Corps units to complete the mission of the amphibious operation. [Ref. 8:p. 2-7 - 2-10]

6. Joint Force Commander (JFC)

The JFC would be the officer selected by the CINC and his staff to be in charge of the units assigned to conduct the amphibious operation. Since it is primarily a maritime operation, it would most likely be a naval officer. The senior representatives of each of the service's participating in the operation would report to the JFC and be responsible to him for that particular service's actions in the operation. [Ref. 9:p. GL-11]

7. Joint Force Air Component Commander (JFACC)

The JFACC receives his authority from the JFC. He will normally be from the service that has the most air assets involved with the amphibious operation. Unless the operation is occurring near airfields that are available for Air Force aircraft to use, this would most likely go to a Naval Aviation Officer (Navy or Marine). The JFACC will be responsible for

planning, coordination, allocation, and tasking of the Joint Force air assets to accomplish the mission assigned by the JFC. [Ref. 10:p. B-5]

B. NAVY ORGANIZATION AND COMMAND

The Navy organization and command is a very important factor in conducting an amphibious assault. The smaller the operation is, the less likely the CINCNAV would be in the area of the amphibious operation. For that reason the CINC, CINCNAV and the JFC would select a commander of the naval units assigned to the operation that would be the on-scene officer in charge of all participating naval units. This officer would have the title of Commander, Naval Forces (COMNAVFOR). [Ref. 9:pp. II-1 - II-11]

1. Officer-in-Tactical Command (OTC)

The OTC for naval forces involved in the amphibious operation is COMNAVFOR. The naval armada could consist of several different Battle Groups. Those that are supporting the Amphibious Task Force (ATF) would report to the Battle Group or Battle Force commander. Those that are part of the ATF would report to Commander Amphibious Task Force (CATF). Each of these officers would report to the OTC/COMNAVFOR. The OTC is responsible for the accomplishment of their assigned mission and defense of all units assigned from threats that may keep them from completing the assigned mission. It is quite likely that the JFC and the COMNAVFOR would be the same

Navy officer for small amphibious operations. [Ref. 6:pp. I-2 - I-3]

Threats are broken up into different warfare areas. Since it would be nearly impossible for the OTC to be actively involved in each of the warfare areas due to their complexity, the Navy has devised the Composite Warfare doctrine. This doctrine increases the efficiency and effectiveness of the OTC in accomplishing his mission. [Ref. 11, pp. 2-1 - 2-2]

a. Composite Warfare Commander (CWC)

The CWC can be the OTC or his designated representative. With the CWC concept, each warfare area has a specified commander that reports to the CWC for his specific area. In this doctrine, the OTC/CWC normally monitors the actions of the commanders designated for each warfare area. This decentralized control allows for rapid response to multiple threats in multiple warfare areas. There are four principle warfare commanders subordinate to the CWC. They are the Antiair Warfare Commander (AAWC), Antisurface Warfare Commander (ASUWC), Antisubmarine Warfare Commander, and Strike Warfare Commander (STWC) (See Figure 3). This allows the CWC to be a manager of all the warfare areas and frees him from becoming entangled in one tactical problem while another grows undetected elsewhere. [Ref. 11:pp. 2-1 - 2-2]

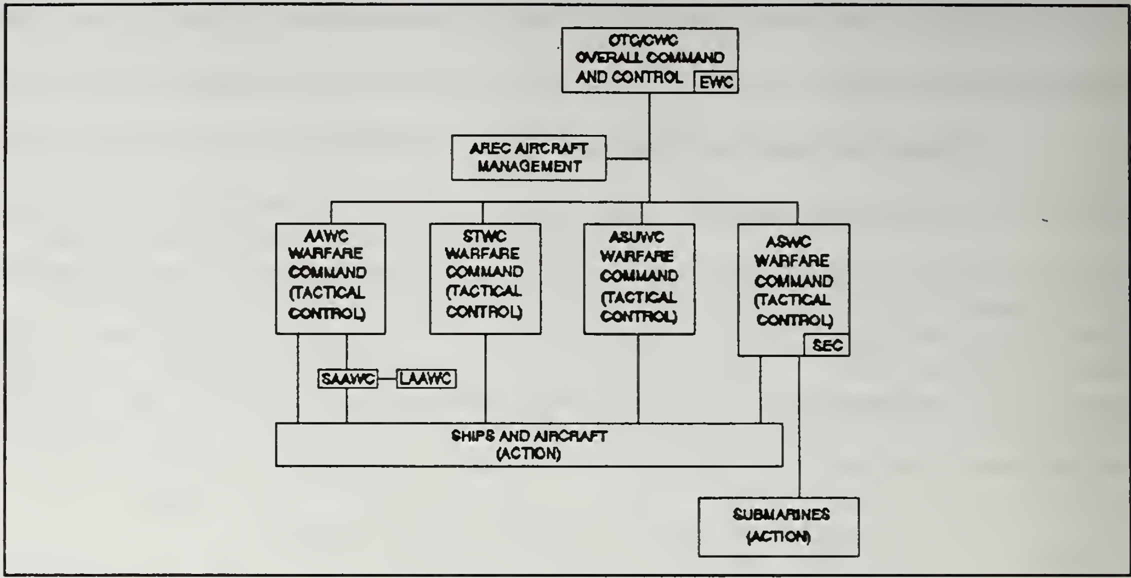


Figure 3 CWC Organization [Ref. 11:p. 2-3]

2. Battle Group or Force Commander

The Battle Group Commander (BGC) is the officer in charge of a Battle Group assigned to the amphibious operations. The Battle Group is:

> A subordinate task organization within the Task Force that includes the non-amphibious surface ships and naval aircraft assigned to the Task Force [Ref. 12:p. 6].

Any amphibious operation which is expected to meet with armed resistance will most likely have one or more carrier battle groups assigned to provide protection and air power projection for the Amphibious Task Force (ATF). When more than one Battle Group is involved, they are collectively called a Battle Force. The Battle Force Commander (BFC) would be the commander of the combined Battle Groups and each BGC would be subordinate to him. Depending on the size of the

operation, the BFC could also be the OTC and the JFC. [Ref. 11:p. A-1 - A-7]

3. Commander Amphibious Task Force (CATF)

The CATF is the naval officer designated in the initiating directive to be in charge of the ATF conducting the amphibious operation. He is responsible for conducting the landing operations and placing the Marines ashore. Throughout this portion of the operation he is responsible for both the Marine and naval force planning and operations to be carried out in the Amphibious Objective Area (AOA). After the Marines have established themselves ashore, the responsibility for these forces shifts to the Commander Landing Force. [Ref. 6:p. II-11]

Under current doctrine, the CATF has his own CWC organization that controls all assets within the AOA. Any supporting forces not within the AOA will have their own CWC organization that controls assets outside of the AOA. See Figure 4. [Ref 13:pp. 9-2 - 9-4]

4. Commander Landing Force (CLF)

> The officer designated by higher authority (in the initiating directive) to command the landing force. Equal in stature to the CATF during the planning phase of the amphibious operation. Chops OPCON to the CATF usually upon embarkation and until termination of the amphibious operation. [Ref. 12:p. 6]

5. Parallel Chain of Command

There are two separate chains of command for the conduct of amphibious operations. The CATF and the CLF each

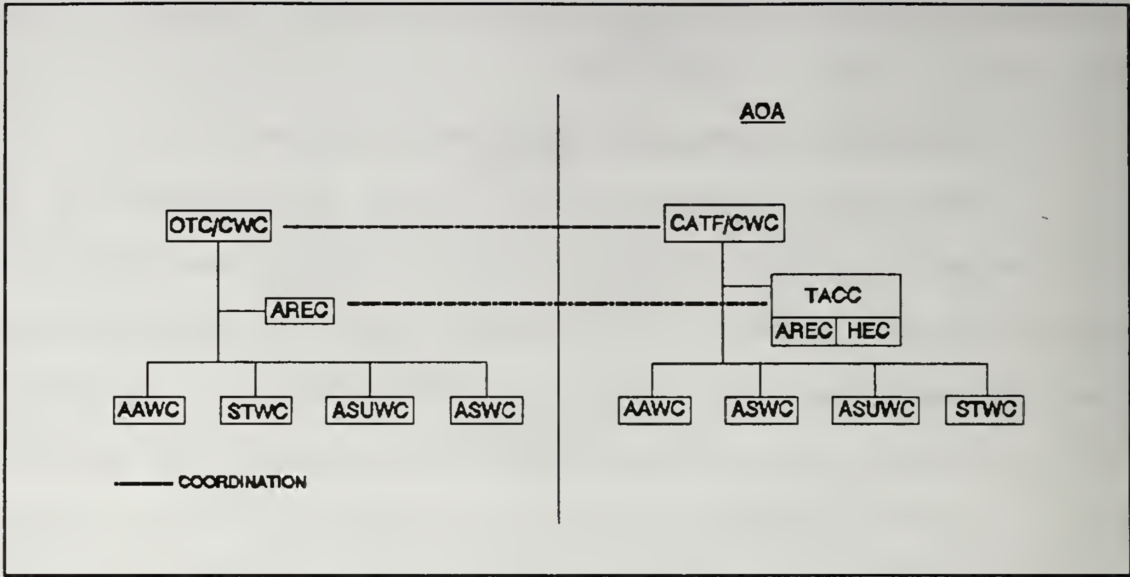


Figure 4 Current CATF CWC Organization [Ref. 13:p. 9-3]

have their own chain of command. The CATF and the CLF are co-equal when it comes to planning and decisions for the operation. Once the forces and equipment are embarked, the CATF assumes overall responsibility for the Amphibious Task Force (ATF) and the operation. Corresponding Naval and LF subordinate commanders are established at all levels of the amphibious organization. Extensive detailed coordination occurs at all levels between both chains of command. The CATF and the CLF work very closely together through their respective chains of command for the success of the amphibious operation. Matters of command that are specific to each service is settled by the respective commander of that service and his chain of command. Matters of command that are of concern to both the Navy force and LF are settled through

corresponding Navy and LF chains of command. [Ref. 6:pp. II-3 - II-4]

6. Composite Warfare

The composite warfare doctrine allows the OTC to aggressively conduct combat operations in all of the principle warfare areas while carrying out the primary mission of the force. It is very flexible and adaptable, allowing for the effective control of multiple Battle Groups operating together over great distances. Subordinate supporting CWCs can be designated by the OTC when the size of the force, separation of forces or distances involved require them. Each subordinate CWC would have warfare commanders mirroring those of the OTC/CWC. [Ref. 3:p. A-2]

a. Antiair Warfare Commander (AAWC)

The AAWC is responsible for the protection of friendly forces from air attack. He must ensure the integration of sea, land, air, and space early warning systems to detect enemy aircraft and missiles [Ref. 3:p. IV-3]. AAWC has Tactical Control (TACON) of assets participating in AAW. He must direct the interception of air threats far enough from the Battle Force to permit in-depth defense and prevent engagement of friendly air assets. [Ref. 13:p. 3-6]

(1) Sector Antiair Warfare Commander (SAAWC). A SAAWC is normally established by the CWC when the number of threats and or Antiair Warfare (AAW) capable units is so large

or spread apart that a single AAW command network would degrade the overall C^3 system of the AAWC. Each SAAWC acts as the AAWC for their designated sector. As such, they have Tactical Control (TACON) of the AAW assets assigned to their sector. When there are multiple sectors, all SAAWCs are required to coordinate with each other and report to the AAWC all activities within their sector. Coordination between SAAWCs becomes critical along the adjoining boundaries of sectors. The AAWC remains the controlling authority over the SAAWCs. [Ref. 14:p. 3-14]

(2) Local Antiair Warfare Coordinator (LAAWC). The LAAWC is on a ship that is linked to the AAW C^3 system of the Battle Force. It acts as the gateway for the C^3 system to those non-link capable ships assigned to it. It provides link data to the ships assigned to it via a one way communication system and in turn manually inputs data into the C^3 system concerning their AAW status and capabilities. Information is normally transferred to the non-link ships via Link 14 (Link 14 is described in Chapter IV). The system is designed to provide only the AAW information relevant to the ships of the LAAWC versus the complete picture of the actual Link. The LAAWC reports to the SAAWC or AAWC, as appropriate, for all ships assigned to him. The LAAWC and the ships assigned constitute a single AAW element in the AAWC's Link. [Ref. 14:p. 3-14]

b. Antisurface Warfare Commander (ASUWC)

The ASUWC is to neutralize hostile naval surface forces and merchant vessels that can threaten the Joint Force. He is in command of coordinating the search, tracking, identification, and engagement of surface vessels. The ASUWC normally has TACON over warships and Surface Combat Air Patrol (SUCAP) aircraft assigned to screen the Battle Force from hostile surface actions. [Ref. 11:p. 10-1]

c. Antisubmarine Warfare Commander (ASWC)

The ASWC denies the effectiveness of hostile submarines against the Battle Force. He is involved in the coordination of the search, localization, tracking, classification, and attack of enemy submarines. The ASWC generally exercises TACON over Antisubmarine Warfare (ASW) assets such as Maritime Patrol Aircraft (MPA), helicopters, towed array ships, and submarines assigned to the Joint Force operating in support of his warfare area. The Submarine Element Coordinator (SEC) is "a cell of the ASWC staff that, when assigned, is responsible for coordinating the actions of direct support submarines." [Ref. 3:p. A-1]

d. Strike Warfare Commander (STWC)

The STWC is responsible for operations to destroy or neutralize enemy targets ashore capable of conducting or supporting air, surface, or subsurface operations against the Joint Force. This normally involves the coordination of

TOMAHAWK missile strikes with the Air Resources Coordinator (AREC), JFACC, and Supporting Arms Control Center (SACC). SACC normally coordinates the Naval Gunfire Support (NGFS) and Close Air Support (CAS) within the AOA. [Ref. 12:p. 11]

e. *Air Resource Coordinator (AREC)*

The AREC does not fall under any of the warfare commanders. He reports directly to the CWC. The AREC can act as an advisor to the CWC or can act as a direct controller of the naval air assets depending on the OTC desires. In either case, however, the AREC must coordinate with the JFACC so that all air assets are integrated into a common plan. [Ref. 11:p. 13-1]

C. MARINE CORPS AAW COMMAND ORGANIZATION

1. Commander Landing Force

> The CLF is either an Army or Marine Corps officer who has operational command of the Landing Force (which may include aviation units). [Ref. 6:p. II-2]

The Landing Force (LF) can either be Army forces and/or Marine Corps forces. When the LF is strictly Marine Corps forces, it will be organized in a Marine Air Ground Task Force (MAGTF). [Ref. 6:p. II-7]

The CLF is responsible for the conduct of operations ashore. He exercises operational control over all forces operating ashore within the Amphibious Objective Area (AOA). [Ref. 6:p. II-11]

2. Air Combat Element (ACE) Commander/Tactical Air Commander (TAC)

The ACE commander has command authority over the Air Combat Element that provides the air assets which support the CLF. The ACE commander, acting as the TAC, exercises command and control of his assets via the MACCS.

> The TAC is the officer (aviator) responsible to the landing commander (CLF) for the control and coordination of air operations within the landing force commander's area of responsibility when control of these operations is passed ashore. [Ref. 4:p. 359]

The TAC is responsible for the direction, supervision, control and coordination of all air operations within the AOA.

3. Senior Air Coordinator (SAC)

The SAC is responsible to the TAC for timely battle management of the MAGTF's air defense system via execution through the MACCS. The SAC coordinates and supervises the functioning of the TACC operations section. He is responsible for the overall execution of the Air Tasking Order (ATO). [Ref. 16:p. 2-6]

4. Sector Antiair Warfare Coordinator (SAAWC) Ashore

The SAAWC is located with the Tactical Air Operations Center (TAOC) and is responsible to the TAC for the decentralized execution of the MAGTF's AAW plan.

> He is responsible for the detailed planning to support the G-3/S-3's (operations section) AAW concept of operations within his assigned sector of responsibility. [Ref. 15:p. 4-7]

The SAAWC supervises and coordinates the activities of the TAOC with other MACCS agencies. He will also provide coordination with agencies that are external to the Marine Corps. [Ref. 16:p. 3-4]

5. Senior Air Director (SAD)

The SAD is the senior director within the TAOC and is responsible for the detailed operation of the TAOC.

> He ensures the proper employment of all offensive and defensive air operations within the TAOC sector of responsibility. He reports to the SAAWC and is responsible for his respective TAOC crew. [Ref. 16:p. 3-4]

D. AREAS OF OPERATION/RESPONSIBILITIES

1. Amphibious Objective Area (AOA)

The AOA is defined as follows:

> A geographical area, delineated in the initiating directive, for purposes of command and control within which is located the objective(s) to be secured by the amphibious task force. This area must be of sufficient size to ensure accomplishment of the amphibious task force's mission and must provide sufficient area for conducting necessary sea, air and land operations. [Ref. 4:p. 27]

2. Naval Air Defense Operational Areas

The air space surrounding a Battle Force is divided into specific areas in which different functions take place within them. With the current Outer Air Battle (OAB) doctrine, there are three designated areas with four possible subsections called zones (See Figure 5). [Ref. 14:pp. 5-1 - 5-3]

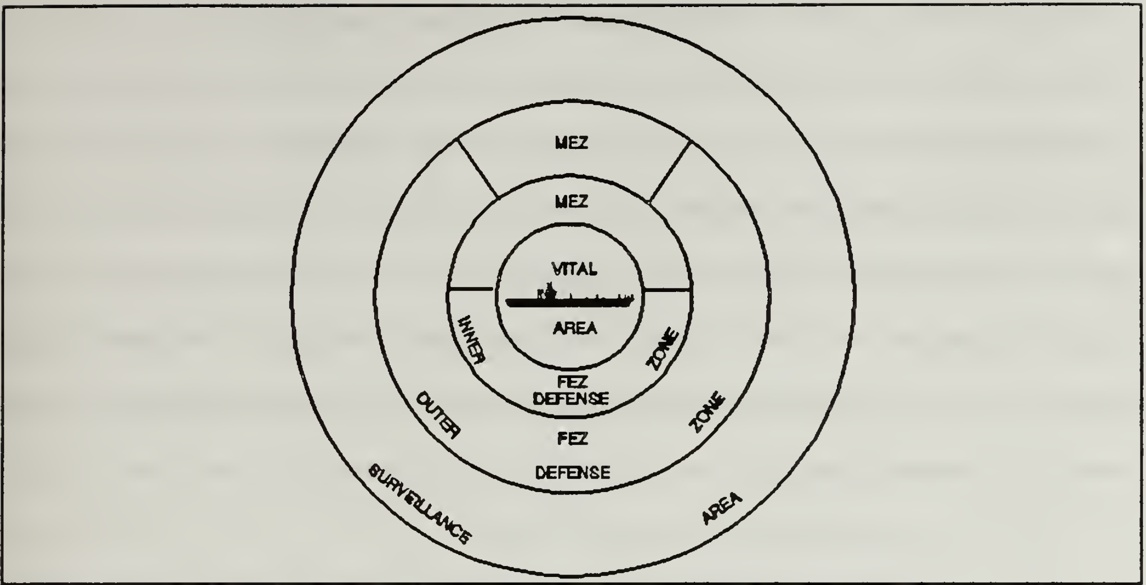


Figure 5 Navy AAW Zones and Areas [Ref. 14:pp. 5-1 - 5-3]

a. Surveillance Area

The Surveillance Area encompasses both the Vital Area (VA) and the Destruction Area (DA) and is the outer limit of the force AAW capabilities. This is where detection, tracking and identification takes place. The dimensions of this area are determined by the force sensors, disposition of the force assets, weather and environmental effects, and the electronic environment in which the force is operating. [Ref. 13:p. 2-6]

b. Vital Area (VA)

The VA is deep within the surveillance area in the Outer Air Battle (OAB). When it comes to amphibious operations, however, the VA can be located on the very fringe of the Surveillance Area depending on the assets providing

surveillance. The VA is an area that contains the units on which the primary mission of the force depends. For certain operations, the VA may be replaced by a particular unit that is critical for an operation to succeed. That asset is then called the High Value Unit (HVU). It is when the VA/HVU is a point near or on the beach that causes the most vulnerability due to greatly decreased early warning, reduced reaction time and increased confusion. [Ref. 13:p. 2-5]

c. Destruction Area (DA)

The DA surrounds the VA. This is the area in which the airborne threat is planned to be destroyed. It varies in dimension depending on the assets available to protect the VA. Within the DA are two different zones. The Outer Defense Zone (ODZ) and the Inner Defense Zone (IDZ) [Ref. 13:p. 2-5]. The ODZ is keyed to the maximum range of the AAW asset's sensors that are protecting the VA/HVU. The IDZ is the engagement zone placed directly around the VA/HVU. Both of these zones can have specific zones of engagement. They are called the Fighter Engagement Zone (FEZ) and Missile Engagement Zone (MEZ). [Ref. 13:pp. 7-4 - 7-15]

(1) Outer Defense Zone (ODZ). The ODZ is an area encompassing the AAW SA outside of the IDZ. It is equivalent in range to the maximum range of the maximum sensor range of all units stationed outside of the IDZ. [Ref. 17:p. F-3]

(2) Inner Defense Zone (IDZ). Aircraft carriers and the threat determine the location of the IDZ. For third world threats, the IDZ is nominally a circle 50 NM around an aircraft carrier. For threats with Soviet weapon systems the range of the circle is increased to 100 NM. The radius of the circle may be adjusted by the CWC based on the expected air threat and geographical considerations. The IDZ is designed to provide the carrier with a dedicated defense area. [Ref. 17:p. F-2]

d. Fighter Engagement Zone (FEZ)

The FEZ is part of the DA that is reserved for intercepting a target with a particular aircraft's weapon system. This is normally located beyond the missile capabilities of the AAW ships of the Battle Force in the OAB, but can be set for around and or near MEZs if need be. [Ref. 17:p. F-2]

e. Missile Engagement Zone (MEZ)

The MEZ is part of the DA where responsibility for engagement rests with the Surface-to-Air Missile (SAM) weapon system of a particular surface unit. When possible, it is separated from the FEZ so as to reduce the possibility of fratricide. [Ref. 17:p. F-3]

E. NAVY PRINCIPLES OF AAW

The principles of AAW have the ultimate goal of neutralizing threats from hostile aircraft or missiles. This

is normally accomplished through several different phases. The initial phase is the advance planning and preparation phase. From this phase comes an AAW plan promulgated by the AAWC. This plan sets guidelines and directives for the disposition of forces, procedures for C^3, preplanned responses for expected threats, and the overall priorities and objectives for AAW. [Ref. 13:p. 9-31]

The second phase is the surveillance of the environment surrounding the force. This involves the detection, tracking, identification and assessment of air threats. The final phase covers the engagement of hostile air tracks. It includes engagement tasking, weapons system acquisition, target intercept, and kill assessment. All of these phases are governed by the AAW doctrine principles set by the Navy. These principles are designed to assist the AAWC in effectively managing the complex and inherent problems of extended ranges and compressed reaction times. [Ref. 13:pp. 2-1 - 2-2]

1. Precise Rules of Engagement (ROE)

These are the directives issued higher authority that establish the circumstances and limitations in which the Battle Force will engage other forces in combat. To be effective and meaningful they must be well defined, unambiguous, specify weapon release authority and be

promulgated to all involved in the operation. [Ref. 13:p. 2-3]

2. Early Warning

Early warning is becoming one of the harder things to execute in AAW, especially in the Near/Overland AAW (NOAAW) environment. Early Warning is derived from several different sources. Ship-board sensors, including active and passive electronic and acoustic sensors, are the platforms that have the most on-station time. Airborne Early Warning aircraft and tactical aircraft provide active and passive electronic sensors as well as visual search for detecting potential targets. Intelligence sources outside the Battle Force can also provide timely warning information. All of the information obtained from these sensors, however, must be integrated into a C^3 system so that it can be distributed in a timely manner to those forces that can use it. [Ref. 13:p. 2-2]

a. Difficulties of Early Warning for NOAAW

With the increasing range of Anti-Ship Missiles (ASMs), increased stealth of aircraft, terrain masking of aircraft in the AOA and launches of missiles from the beach, it becomes increasingly critical to have early warning. Unfortunately the Navy has few assets that are capable of providing this warning in the NOAAW environment. All shipborne radars are susceptible to terrain masking which can

cover the approach of aircraft attempting to attack ships close to the beach. The E-2 HAWKEYE (described in more detail in the Chapter IV) and other tactical aircraft can only provide limited radar coverage when in the NOAAW environment. The E-3 SENTRY provides an acceptable NOAAW capability, but there is a limited number of them and when they suddenly move into an area, they provide excellent "tipper" information to the enemy. Even when Marine air defense assets are established ashore, terrain can still interfere with the surveillance of the AOA with their air search radars. As a result of the drastically reduced early warning in NOAAW, quick reaction tactics and procedures are a necessity. [Ref. 18:p. 1]

3. Defense in Depth (DID)

DID is a key element in the survival of a naval Battle Force. This defense requires the establishment of mutually supporting disposition of AAW forces to absorb and progressively reduce an air attack. The AAWC achieves defense in depth by employing multiple surveillance systems to detect the enemy at maximum range (early warning) and by using weapon systems that can intercept the threat as soon as possible. The engagement of the threat must be sustained through the different layers of the defense until the air threat is eliminated. [Ref. 13:pp. 2-3 - 2-4]

a. Difficulties of DID for NOAAW

DID is very limited in the AOA. For naval forces at sea, DID is normally obtained by placing assets 360 degrees around the VA or High Value Unit (HVU) at several different distances. In the AOA, half of the circle around the ATF is covered by hostile territory. This allows for coverage by air or ground AAW assets only, which themselves become vulnerable to the enemies ground and air assets. As a result, there are many times when there is almost no DID at all for the ATF. [Ref. 13:pp. 9-14 - 9-17]

4. Optimum Use of Available Assets

The optimum use of assets available strengths must be exploited while reducing any of their weaknesses in the NOAAW environment. Very seldom does a commander have enough of everything that he would like in order to conduct a military operation. The disposition of both air and naval forces must mutually support one another in the accomplishment of the NOAAW mission. Vulnerabilities of amphibious and auxiliary ships operating near the beach must be well understood by all participating in the air defense of the AOA. Assets must be placed to protect the ground forces that are ashore from hostile air attack. This could be in the form of placing an AEGIS or NTU cruiser only a few miles off the beach to protect the Marines ashore or to augment their air defenses. [Ref. 13:pp. 9-16 - 9-18]

5. Countermeasures

Countermeasure are the actions taken to deny hostile forces from accomplishing a particular function of the targeting process. They can be passive and or active in nature, but must be coordinated across the Battle Force so as to not interfere with our own defensive or offensive operations. These actions essentially are attempts at breaking up the enemy's ability to launch weapons at the Battle Force. The countermeasures include:

- counter surveillance;
- counter communications;
- counter deception;
- counter jamming;
- counter targeting;
- counter weapon (hard and soft kill). [Ref. 14:pp. 4-4 - 4-9]

6. Coordination and Control

Coordination and control are primary concerns of the AAWC. The individual sensors and weapons of units assigned to the Battle Force determine the true combat potential of that force. However, it is the coordination and control through the Command, Control and Communication (C^3) systems of the Battle Force that generally determine the extent to which that potential can be met. It is the objective of all commanders to see, know and direct all that occurs in a battle. This

requires the reliable, timely and comprehensive transfer of data from the battle environment; the display of the data in a form that lends itself to accurate and rapid absorption by those needing it; quick and reliable dissemination of the commander's decision to all of their subordinates; and a means of continuously repeating this process. [Ref. 13:pp. 2-6 - 2-8] This, in fact, is an Observe, Orient, Decide, and Act (OODA) Loop and is the generic process that all C^3 system utilize [Ref. 5:p. 22 to 23]. When degraded by poor coordination and control by the subordinates or hostile enemy actions (i.e., jamming) the potential begins to decrease rapidly. [Ref. 19:pp. 185-194]

F. MARINE CORPS PRINCIPLES OF AAW

There are three Marine Corps AAW principles that have evolved throughout the years and have proven to be necessary in order to achieve and preserve air superiority. These principles include destruction in depth, mutual support, and centralized coordination and decentralized control. [Ref. 7:p. 1-2]

1. Destruction in Depth

This principle is based on having threat detection and destruction begin as far as possible from the vital area or defended area and continuing as long as the threat exists. The AAW area is divided into sectors which are determined by factors such as effective communication range, detection

range, both enemy and friendly weapons range and the threat from air or surface attack. [Ref. 7:p. 1-2]

2. Mutual Support

"AAW weapons are employed and/or located to ensure continuity of engagement" [Ref. 7:p. 1-2]. It is important to structure the employment of AAW assets such that targets can be engaged by more than one AAW element. This reduces the possibility of aircraft or missiles penetrating the defended area and therefore increasing the survivability of the landing force. [Ref. 7:p. 1-2]

> This integrated and overlapping pattern of mutual support and continuity of engagement minimizes any reduction in effectiveness of the AAW system resulting from the loss of one or more AAW elements. [Ref. 7:p. 1-2]

3. Centralized Coordination and Decentralized Control

In order for the AAW system to reduce reaction time and minimize damage, it must have the capability to operate in a decentralized mode. Centralized Command and Control (C^2) of AAW is the CLF's responsibility, and is normally delegated to the Tactical Air Commander (TAC). The TAC exercises C^2 via the various elements of the Marine Air Command and Control System (MACCS). Decentralization occurs when authority and control is delegated to subordinate agencies that form the MACCS. These subordinate agencies operate in the "silence is consent" mode. Subordinate agencies can react to a threat

immediately unless higher authority intercedes. [Ref. 7:p.1-2]

G. MARINE AIR DEFENSE SECTOR

The Amphibious Ojective Area (AOA) is divided into sectors of responsibility. One of these sectors will be assigned to the Marine Air Ground Task Force (MAGTF) commander. This sector of responsibility gets further divided into air defense sectors which must be designated and clearly defined. The air defense sector is identified with three other areas, the vital area, the destruction area and the surveillance area. [Ref. 7:p. 3-2]

1. Vital Area

A Vital Area is a designated area for which air defense units provide protection.

> It contains the facilities, units, and installations necessary for the landing force to accomplish its mission. [Ref. 7:p. 3-2]

In any given operation, more than one vital area can be designated. Vital areas can include airfields, unit headquarters and logistical support units. [Ref. 7:p. 3-2]

2. Destruction Area

> The Destruction Area is that portion of the sector for air defense in which destruction or defeat of the enemy airborne threat is planned and executed. [Ref. 7:p. 3-2]

This area is determined by factors such as the airborne threat, effective communication range, surveillance

area, terrain and weapons engagement capability. The Destruction Area is partitioned into three dimensional (3D) Weapon Engagement Zones (WEZs). These include the MEZ, crossover zone, FEZ and the Air Intercept Zone (AIZ). [Ref. 7:p. 3-2]

a. *Missile Engagement Zone (MEZ)*

The MEZ is a three dimensional subdivision of the destruction area in which surface to air missiles are the primary weapons employed for the destruction of airborne threats. [Ref. 7:p. 3-2]

b. *Crossover Zone*

The crossover zone is a three dimensional subdivision of the destruction area which lies between the MEZ and the Air Intercept Zone in which airborne targets become a SAM target.

> The crossover zone is the airspace separating adjacent engagement zones where more than one type of weapons system may engage the enemy airborne threat. However, weapons systems making engagements in this zone will normally be under positive control of the TAOC, EW/C or airborne early warning aircraft. [Ref. 7:p. 3-3]

c. *Air Intercept Zone (AIZ)*

The AIZ is a three dimensional subdivision of the destruction area in which the planned destruction of airborne threats is primarily conducted via air to air engagements with the employment of fighters. [Ref. 7:p. 3-3]

d. *Fighter Engagement Zone (FEZ)*

The FEZ is a three dimensional subdivision of the destruction area in which fighter aircraft are the primary platform used to engage airborne threats. The Air Intercept Zone (AIZ) may be subdivided into FEZ's. [Ref. 7:p. 3-3]

3. Surveillance Area

This area is where air search, detection and tracking are conducted. The surveillance area should extend beyond the destruction area in order to provide ample warning and reaction time for target engagement. The destruction area is only a portion of the surveillance area and is oriented towards the designated sector of responsibility. The surveillance area may extend into other air defense sectors. [Ref. 7:p. 3-5]

Figure 6 is a possible arrangement of the destruction area and its subdivisions and the surveillance area. The actual arrangement depends on the tactical situation and asset availability.

H. C^3 AND AAW IN SUPPORT OF AMPHIBIOUS OPERATIONS

A carefully planned and executed C^2 organization provides the MAGTF commander the ability to successfully conduct AAW operations. "Command and Control enables the organization, direction, coordination, and control of AAW assets." [Ref. 15:p. 3-1].

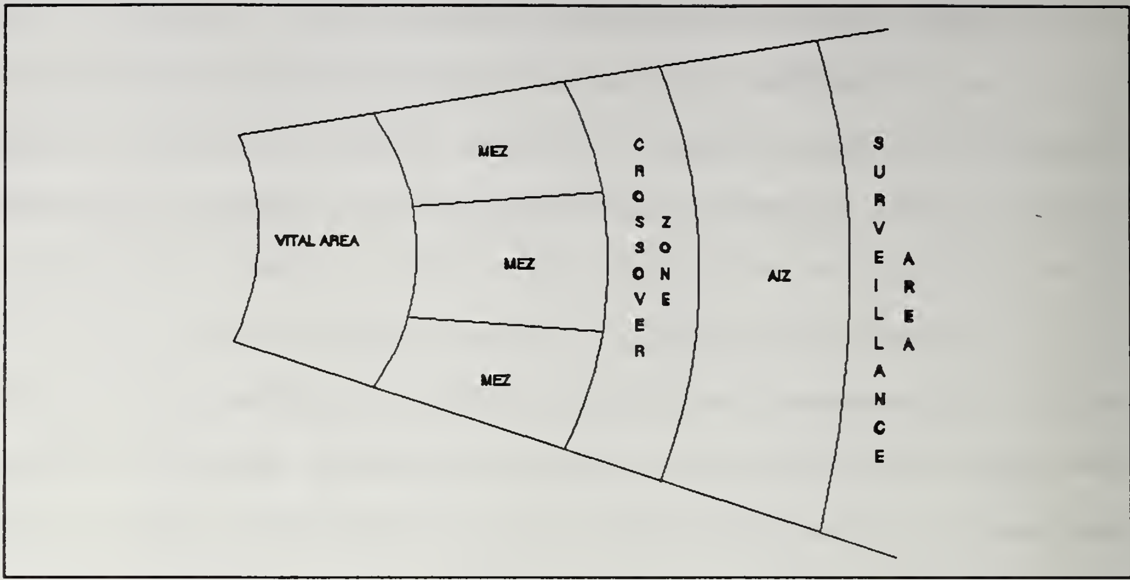


Figure 6 Marine Corps FEZ/MEZ Concept [Ref. 7: p. 3-4]

C^2 is exercised by the ACE commander acting as the TAC through the MACCS. The TACC (ashore) is the command agency through which the TAC exercises command. The TAC is delegated control authority by the MAGTF commander [Ref. 15:p. 3-2]. Communications is provided by the Marine Wing Communications Squadron (MWCS) that ties all the MACCS agencies into one cohesive functioning organization [Ref. 7:p 2-9].

AAW in support of amphibious operations requires extensive planning and close coordination. It is very complex in nature. AAW in support of amphibious operations can be described in five phases. These phases include air defense during movement to the Amphibious Objective Area (AOA), preassault AAW, AAW in support of the assault phase, phasing control ashore and postassault operations. Postassault

operations refers to air defense conducted once control is phased to the CLF ashore. [Ref. 7:p. 3-9].

1. Movement to AOA

The responsibility for ATF AAW rests with the CATF during movement of the Landing Force (LF) to the AOA. Protection of the ATF is paramount. Air defense assets will normally consist of carrier fixed wing aircraft and air defense capable ships from the Battle Force. The CATF will normally augment his air defense with organic weapons providing point defense with the use of AV-8Bs, STINGERS, helicopters and ships capable of firing air to air weaponry. Prudent use of these assets should be exercised since there is a limited amount of resources the LF can expend which may be needed in order to accomplish the mission once ashore. [Ref. 7:p. 3-9]

2. Preassault AAW

Preassault Offensive AAW (OAAW) increases the survivability of the ATF prior to entering the AOA. In order to increase the possibility of a successful landing, air superiority must be established. OAAW tries to destroy the enemies offensive AAW assets prior to their employment. OAAW should target and destroy as much as possible the opposing force's airfields, logistic support facilities and air defense systems. This will degrade the opposing force's capability to

interfere with the ATF's use of its air assets. [Ref. 7:p. 3-9]

These operations are coordinated and controlled via the CATF's TACC (afloat). Again, it is critical that the use of the LF's assets be limited. The LF's assets must be dedicated for the assault. If some of the LF's assets are expended they will need to be replaced prior to the assault. [Ref. 7:p. 9]

3. AAW in the Assault Phase

This is probably the most crucial phase for success of the amphibious landing. Air superiority that may have been gained during the preassault phase must be maintained and exploited. The primary concern is air defense of the assault troops. The CATF exercises control of air operations and airspace control via the use of his Force AAWC (FAAWC) and the TACC (afloat). The AAW area is divided into two sectors for control of AAW assets, the landward sector and the seaward sector. These sectors are controlled via Sector Antiair Warfare Coordinators (SAAWCs). Each SAAWC controls air intercept aircraft, Airborne Early Warning (AEW) aircraft and air defense capable ships within his sector. It is critical that air surveillance be provided by AEW aircraft and shipboard radars. Figure 7 depicts the assault AAW configuration. [Ref. 20:p. 15]

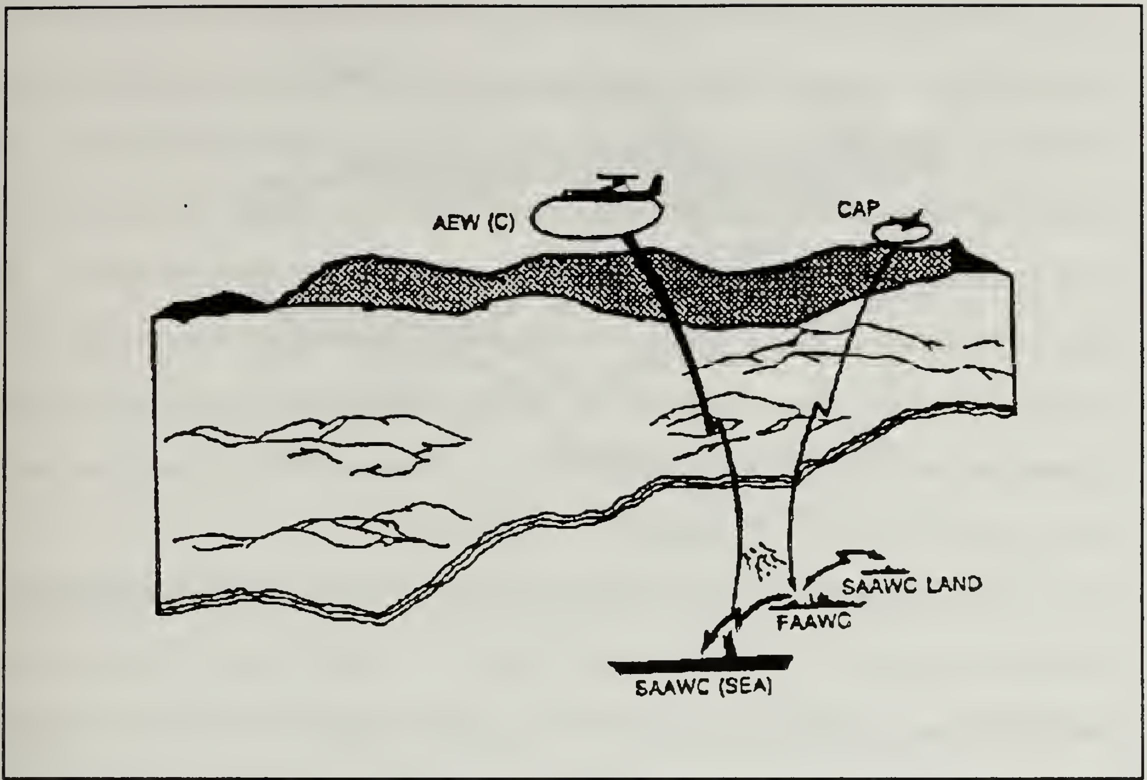


Figure 7 AAW in Assault Phase [Ref. 7:p. 3-10]

As the LF assets continue to come ashore, initial air defense ashore is provided by Low Altitude Air Defense (LAAD) teams. Control and coordination is provided by the team's section leaders who are located in the assault Fire Support Coordination Center (FSCC) which provide deconfliction between friendly aircraft in support of the assault and threat aircraft. The senior LAAD commander ashore will establish voice communications with his sections and the CATF's landward SAAWC. He will eventually move into the Direct Air Support Center (DASC), when operational, in order to provide better deconfliction and coordination of Offensive Air Support (OAS) and threat aircraft. [Ref. 7:p. 3-10]

Carrier air will continue to provide air defense for the LF via the employment of Combat Air Patrol's (CAPs) under control of the respective SAAWC. Deconfliction and coordination between CAP aircraft and the LAAD elements will be executed between the LAAD commander and the SAAWCs. For the landward sector, CAP aircraft will normally be responsible for threats in the medium to high altitude range while LAAD elements will be responsible for the low altitude threats. [Ref. 7:p. 3-10]

As more forces are phased ashore, additional air defense assets become operational. LAAD will continue to provide low altitude air defense for aircraft such as the AV-8B, OV-10 and helicopters that commence operating from forward bases ashore. Elements of the HAWK firing platoon augmented by an Early Warning and Control (EW/C) site are phased in and provide additional air defense capabilities ashore. The EW/C provides land based surveillance and coordination for inland AAW assets. These AAW assets are controlled by the CATF's AAWC through the landward SAAWC. Data exchange and coordination is conducted among HAWK, the EW/C, LAAD and the SAAWC via established communications nets. See Figure 8. [Ref. 7:pp. 3-10 - 3-12]

As the air defense system is strengthened by additional HAWK missile batteries and LAAD elements coming ashore, the TAOC will also be phased ashore. Once the TAOC is operational, it will activate voice communications with the

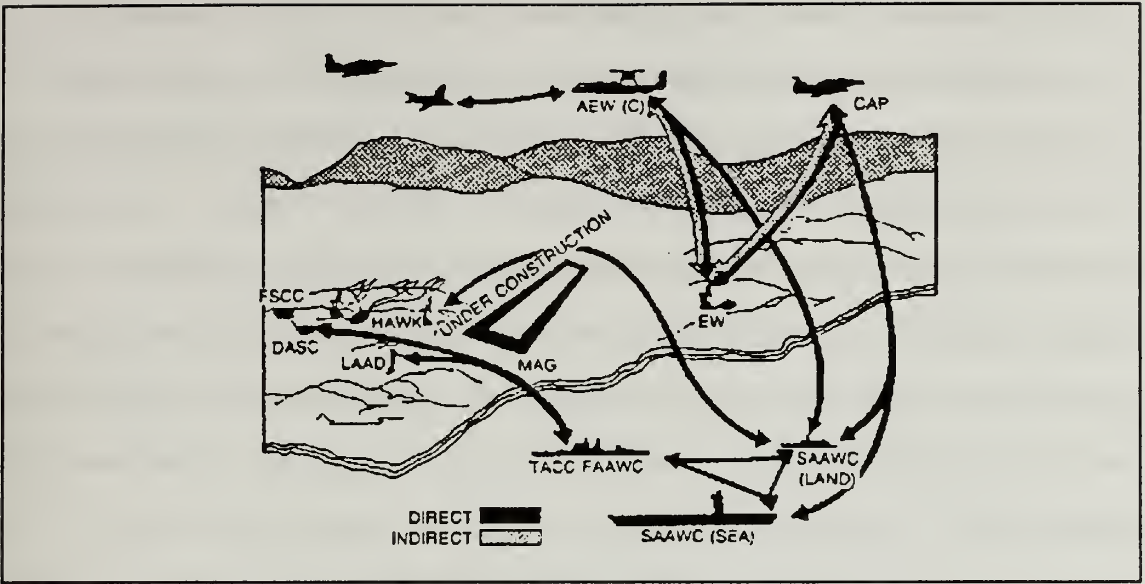


Figure 8 Landing Force AAW Means Ashore [Ref. 7:p. 3-12]

TACC FAAWC, EW/C, HAWK missile batteries, LAAD elements, AEW platforms and CAP aircraft. Data link operation will commence and may consist of the TAOC conducting Army Tactical Data Link-1 (ATDL-1) with the HAWK missile batteries, TADIL-C with CAP aircraft, TADIL-A with the TACC (afloat), FAAWC and AEW platforms, and TADIL-B with the EW/C site. [Ref. 7:p. 3-11]

4. Phasing Control Ashore

Once the TAOC is fully operational, it can assume control of air defense for the landward sector upon approval by the CATF. The FAAWC will be in direct control of the TAOC. Once the landward SAAWC responsibilities are transferred ashore, it is co-located with the TAOC, and the TAOC becomes fully operational. It can assume the duties of the Tactical Air Direction Center (TADC) until the TACC is

phased ashore. The landward SAAWC afloat will then revert to a backup monitor status ready to assume control again if required. Normally, as equipment is phased ashore, the Tactical Air Direction Center (TADC) will be under construction near the Expeditionary Airfield (EAF). Until these agencies assume control ashore, the MAGTF's SAAWC is responsible to the CATF's FAAWC for landward air defense and to the CATF's Tactical Air Officer (TAO) for landward air operations. See Figure 9. [Ref. 7:p. 3-12]

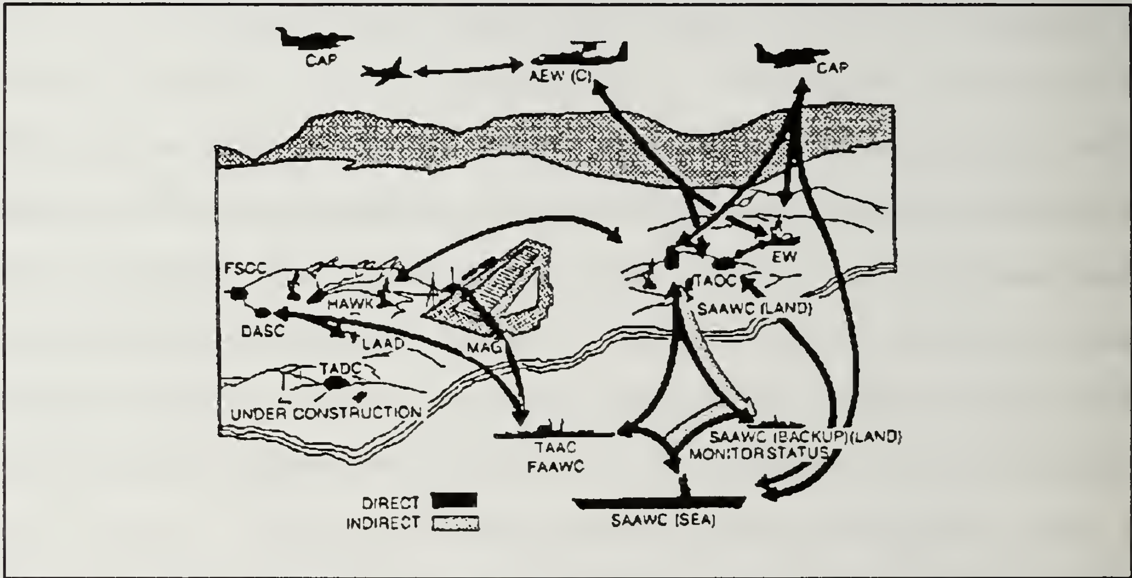


Figure 9 TAOC Ashore [Ref. 7:p. 3-12]

During this period several other MACCS agencies are phased ashore and establish Expeditionary Airfield's (EAF) for the support of Marine fixed wing assets. Once the EAF's are operational with air defense aircraft, an integrated air defense with HAWK missile batteries employing the FEZ/MEZ concept is employed. [Ref. 7:p. 3-13]

As the TACC is phased ashore and becomes operational, it establishes communications with the TAOC, the Direct Air Support Center (DASC), the LF's aviation assets and the TACC (afloat). When these communication links have been established, it will assume the role of TADC. The Commander of the Landing Force (CLF), who is now ashore, will conduct control and coordination between his AAW C^3 system and the TACC (afloat) through the TADC. When operations have become well established, the CLF can request control of the AOA's airspace and aviation assets to be phased ashore and have the TACC (afloat) phased ashore. See Figure 10. [Ref. 7:p. 3-13]

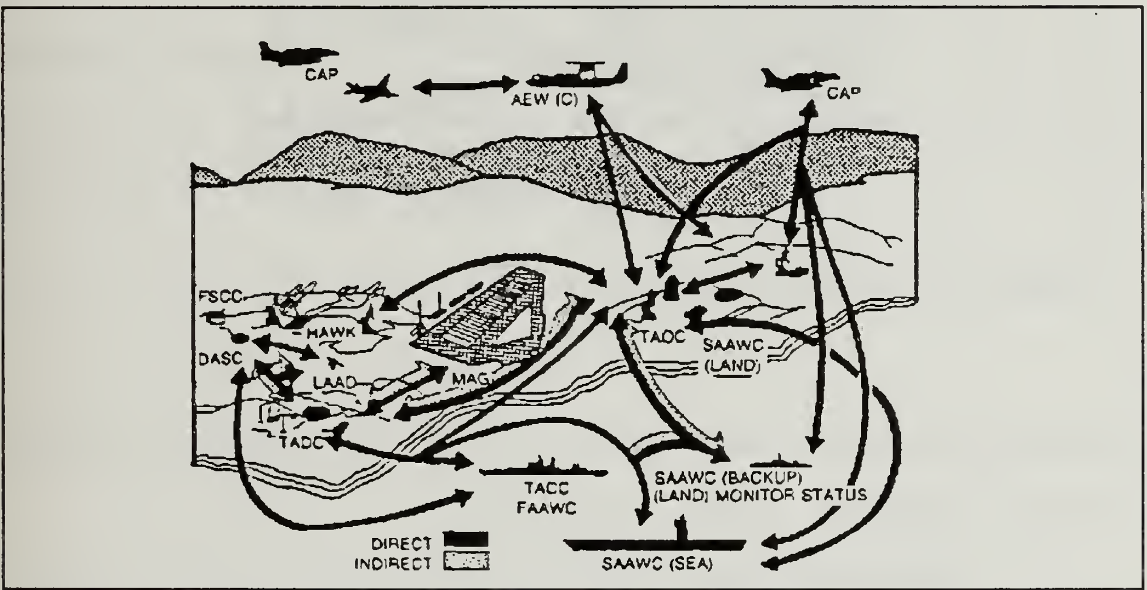


Figure 10 TADC Ashore [Ref. 7:p. 3-14]

Upon approval from the CATF and the TADC becoming fully operational, the TADC becomes the TACC (ashore). Overall control is then phased ashore reverting the TACC (afloat) to a TADC status which will monitor the TACC (ashore)

ready to assume control again if required. The CLF now has overall AAW and airspace management control responsibilities for the AOA which he exercises via the TACC (ashore). See Figure 11.

The entire process of establishing a MACCS ashore can take anywhere from 18 - 21 days. This process is situation

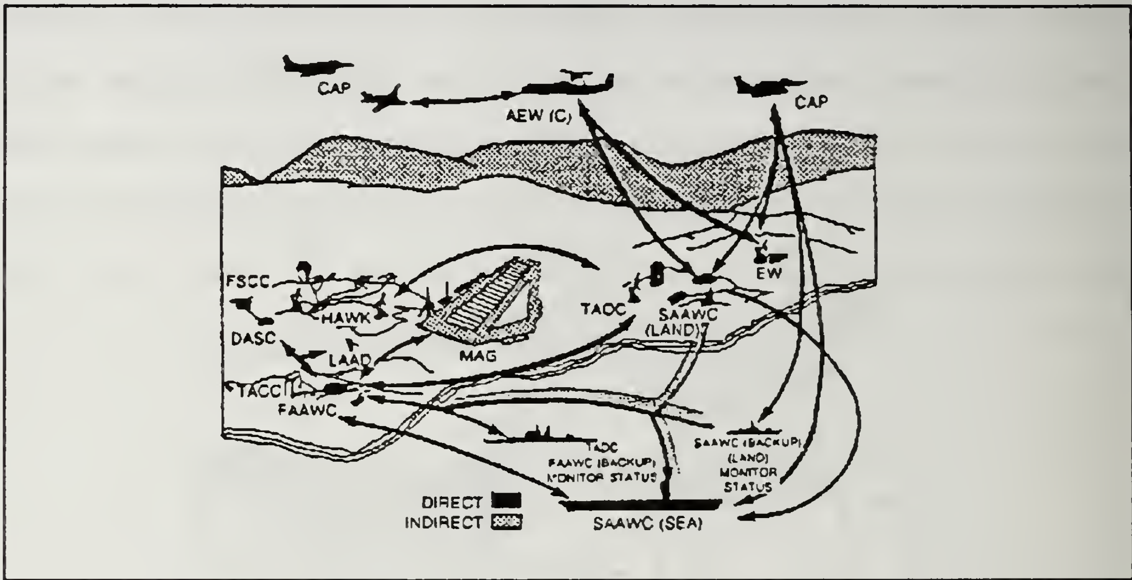


Figure 11 TACC Ashore [Ref. 7:p. 3-14]

dependent and can take longer if the amphibious landing is severely opposed. [Ref. 21:p. 4-8]

5. Postassault Operations

This includes operations conducted once the amphibious operation is completed. There are several factors that are used as guidelines to determine when the amphibious operation is over but the underlying factor is when the CLF determines that he has sufficient combat power and is ready to assume

full responsibility for subsequent operations. At this point the CATF and CLF will recommend to higher authority that the amphibious operation be terminated. Once officially terminated, the CLF will conduct postassault operations. [Ref. 7:p. 3-13]

I. SUMMARY

Each service is organized differently for war. It is important to grasp a basic understanding of the principal commanders and their functions involved in AAW. This leads to a better understanding of those responsible for employing AAW doctrine. The next chapter provides a discussion of the Command, Control, and Communication (C^3) systems that allow commanders to exercise Command and Control (C^2) and employ AAW principles as discussed earlier.

IV. CURRENT C^3 SYSTEMS

A. COMMAND, CONTROL AND COMMUNICATION (C^3) SYSTEMS

The Joint Chiefs of Staff (JCS) do not have a definition for C^3 systems. They do, however, provide a definition for Command and Control (C^2), which was discussed in Chapter II. We are using C^3 because it emphasizes the importance of communications within the C^2 definition. A C^3 system links active and passive defense and attack capabilities to provide timely assessment of the threat, rapid dissemination of tactical warning, targeting data, and mission tasking to the appropriate assets for all warfare areas. For every operational unit linked with the C^3 system, it must provide rapid communication among the units, a fusion capability, a decision making process, warning systems, and operational means [Ref. 22:p. III-25]. Although most of the US Navy's C^3 systems are designed for the fast pace of Antiair Warfare (AAW), they can also provide critical data for other warfare areas. These C^3 system must use their limited resources efficiently to manage tactical air defense operations without significant loss to other operational capabilities. [Ref. 22:p. III-25]

1. Tactical Data Information Links (TADILs)

Tactical Data Information Links (TADILs) are used in the US Navy as the primary means of communications for tactical data exchange between the various units of a Battle Force. Most TADILs are also known as "Links". There are different types of Links for different types of assets and the missions they are assigned. [Ref. 23:pp. 18-19]

a. TADIL-A (Link 11)

TADIL-A is also known as Link 11 and is the primary data exchange system between naval combatants, airborne sensor platforms and certain shore establishments that supports all warfare areas. This communication system is designed to allow a unit within the C^3 system to access all available information from the other units participating in the system. Data is exchanged according to Link 11 net protocol shown in Figure 12.

TADIL-A requires that one ship be designated as the Net Control Station (NECOS) to ensure an orderly flow of data throughout the C^3 system. [Ref. 23:p. 18]

> ...It acts to establish the net and to supervise the protocol governing when each participating unit transmits its own ship track report to the rest of the net. The other ships act as picket stations, listening for all data, but broadcasting only once per net cycle in response to a roll-call polling from the net control station. Broadcast track information is received by all other net members and entered as remote track data in their command and control computers. [Ref. 24:pp. 25-26]

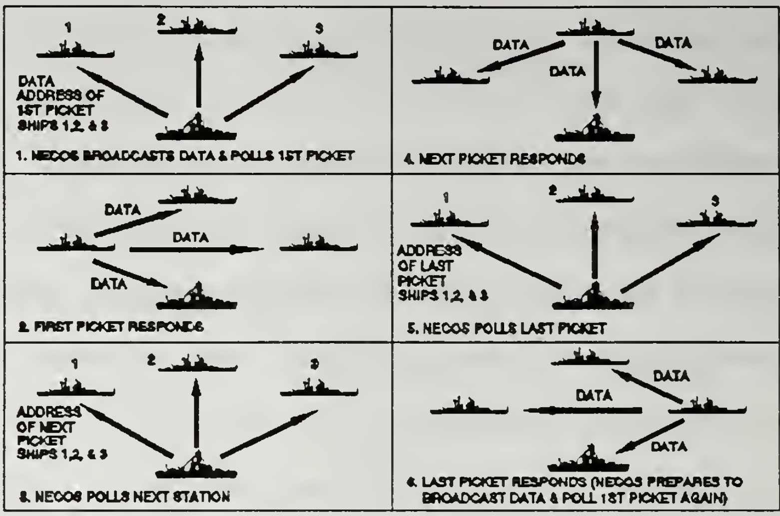


Figure 12 Link 11 Net Cycle Operations [Ref. 24:p. 26]

With continuing modifications to Link 11 over the years, it has proven to be a fairly reliable system. It does provide for encryption of the data, but is not jam resistant. Additionally, for every unit that participates in the Link, the net cycle time increases. Therefore, there is a tradeoff on the number of units in the Link and the Links' ability to be a near real time data exchange system. [Ref. 23:pp. 18-19]

b. TADIL-B

TADIL-B is a secure point to point serial Link that has no Link designation. It is a ground based data exchange system used primarily by the Army, Air Force, and Marine Corps for air defense. It is comparable to, but not compatible with Link 11. TADIL-B and the Army Tactical Data Link-1 (ATDL-1) are different Links but operate in a similar manner and are fully interoperable. [Ref. 23:p. 18]

c. TADIL-C (Link 4A)

Link 4A or TADIL-C is the Navy and Marine Corps primary aircraft data exchange system between a controlling sensor platform and an aircraft intercepting an air track. It provides a one or two way data exchange between the controlling platform and the interceptor's weapons control system. This Link is not encrypted, nor is it jam resistant. Most controlling units are able to conduct several Link 4A operations at the same time. [Ref. 23:p. 18]

d. Link 14

Link 14 has no TADIL designation. It is only a one way broadcast system that provides limited Link 11 data to ships that are not equipped with TADIL-A via a teletype printout. At best it is a slow semiautomatic communications system. Although Link 14 is still present, it is only used in older combatants and auxiliary ships. [Ref. 23:p. 19]

e. TADIL-J (Link 16)

This is the planned replacement for all exsisting US aircraft data Links. The Link consists of common synchronizing pulses combined with frequency hoping over a bandwidth of several hundred MHZ on a pulse to pulse basis. Units within the net are assigned time slots in the system's cycle. One unit is designated as the time reference and maintains the timing of the net. In each slot, every other message pulse is redundant, so that messages can be

reconstructed during heavy jamming. The beginning of each slot has a jitter that varies the actual begining of data transmission. The data rate can be doubled by eliminating both the jitter and the redundant message pulse, but its ability to operate in jamming environments is greatly reduced. [Ref. 23:p. 19]

f. Communication Systems and C^3 Systems

All of these Link communication systems are not in and of themselves a C^3 system. They form a means of communications for data exchange between the units in a C^3 system. They are not the sole means of communication either. Link operations in the USN are operated with several voice radio networks (nets) that provide additional Coordination and Reporting (C&R) for the C^3 system. Normally, these C&R nets supplement the Link's communications and provide human cognitive control and confirmation of data that is not easily absorbed by the operators from the Link. The Links and C&R nets each form a subsystem of a C^3 system. [Ref. 23:pp. 84-86]

g. Equipment, Facilities, Personnel and Procedures

The equipment, facilities, personnel and procedures portion of a C^3 system are located within each participating unit of a C^3 system and are designed to maximize each asset's capabilities in the C^3 process. For most Navy ships, this is done in the Combat Information Center (CIC).

Personnel receive specialized training for the particular watch stations they are assigned that provides inputs to or operates computers within the C^3 system. The C^3 system process within an individual force is guided by the OTC's plans and instructions promulgated to the force. [Ref. 13:pp. 3-1 - 3-12]

For larger ships (i.e., CVs, LHAs, LHDs, etc.) there are several different cells for specific areas of information that provide inputs to the CIC and the C^3 system. CIC is the heart and brains of naval combatants. All sensor and weapon control systems are fused within the CIC and integrated with the C^3 system through various means. Each sensor system and weapon control system in a ship forms a subsystem of the ship's and the Battle Force's C^3 system. [Ref. 13:pp. 4-22 - 4-24]

B. NAVAL TACTICAL DATA SYSTEM (NTDS)

The advent of radar for naval forces in World War II (WW II) produced a change in paradigms for anitair warfare. Radar allowed for the advance warning of aircraft approaching the fleet. To maximize on the advantages of radar, CICs were developed in warships for the manual plotting and tracking of air contacts. Additionally, radio voice networks were developed to assist Combat Air Patrol (CAP) aircraft in intercepting aircraft prior to reaching the AA gunfire of the fleet. This C^3 system was slow, manpower intensive, prone to

human error and did not always have accurate and reliable data from the early model radars, but was much better than no system at all. By the Korean war, several factors combined to produce a need for a more automated C^3 system. Jet aircraft and self-guided missiles had replaced the propeller driven aircraft and free fall bombs of WW II. The rate at which tactical data changed increased greatly and the size of the enviroment grew with both weapons and sensor improvements. This need lead to project COSMOS. COSMOS was an extensive study covering data communications, data processing and data exchange between ships. A project was also started at Cornell Aeronautical Laboratories to design an intercept tracking and control console. This project concentrated on the use of digital computers for the correlation of radar data from several platforms and the solution of threat evaluation and weapon assignment problems. In 1954 Project LAMPLIGHT was commenced to formulate recommendations for continental air defense at the Massachusetts Institute of Technology. The fruition of these projects lead to the requirements that produced the NTDS. [Ref. 26:pp. 53-54]

NTDS has been organized around two related functions. Integration of available sensor data into a meaningful tactical plot is the first function. This is generally done in a two dimensional (2D) compiled summary of the surrounding sea and air environment out to 512 nm. The plot also attempts

to identify friendly and hostile tracks while others are marked as unknown tracks. There are three basic category of tracks; air, surface, and subsurface. Secondly,

> ... they often partially or completely automate the results of decisions taken by means of the plot. For example, using an electronic plot, an officer may designate a target for attack. This designation at a console in CIC will result automatically in the proper orders being given to, say, a surface-to-surface missile launcher. In some systems automation extends further. The combat system identifies particularly urgent threats and initiates reactions (such as missile firings) against them. In such cases the display allows the monitoring officer to abort the reaction while it is being made. [Ref. 23:p. 48]

It is important to realize that NTDS is primarily a coordination and display system. Although the system is capable of automated alerts and recommendations to engage tracks, this is based solely on a track's course and speed. It does not take into account possible weapons capabilities, tactics the enemy may be using or other tactical information that may influence a decision to engage. The Tactical Action Officer (TAO) and the Commanding Officer (CO) use their experience and knowledge to add information needed for decisions to engage tracks. [Ref.23:p. 81]

1. Facilities

NTDS facilities have been installed on all major warships from the late 1960's. This process has evolved over the last 30 years to a point that all combatants since 1974 have been built with NTDS. Only with the advent of the TICONDEROGA class cruiser was a more modern system installed

on new construction ships. Modifications have been made to most ships throughout the years. The system has evolved from the early days of manual entry of track data into the console to computer systems that automatically integrate sensor, weapon control and Link 11 data. Amphibious ships that play a key role in C^3, such as the LCCs and LHAs, have also received the NTDS. There have also been several shore sites on the East and West coast of the US that have had NTDS installed to aid in training and to conduct exercises with air and surface assets. [Ref. 26:pp. 56-59]

2. Equipment

NTDS requires a large amount of a ship's volume to be able to accomplish the fusion of ship's sensors, weapon systems, and display consoles with a communication system that exchanges data with other ships in the Battle Force. Computers are required at almost every point of the system to overcome the rapidly changing environment of AAW and reduce human error. Additionally, since most of the early weapon systems and peripheral systems were of an analog design, numerous computers were needed to act as a translator for data flow between them and NTDS. The computers for the NTDS are specifically built for the military and meet Military Standard (MIL-STD) requirements. Because of the MIL-STD requirements, military computers have generally lagged far behind the operating capabilities of commercial computers and cost much

more due to the relatively low volume of production and special requirements made by the military. The UYK-7 and UYK-20 computers form the major portion of the computers used in current versions of the NTDS and are based on 1960's technology. [Ref. 27:pp.27-39]

3. Communications

a. Radio Voice Nets

Link operations in the USN are operated with several radio voice nets that provide additional C&R for the C^3 system. Normally, these C&R nets supplement the Link's communications and provide human cognitive control and confirmation of data that is not easily absorbed by the operators from the Link. Since there are several warfare areas that use data from the NTDS, there is usually at least one voice net per warfare area to provide C&R for that particular area. Additionally, there is always one voice net dedicated for operators to communicate with the Net Control Station (NECOS) to ensure that the Link operates as efficiently and effectively as possible. [Ref. 25:pp. 3-1 - 3-5]

b. Links

The NTDS is capable of numerous types of Link operations. Most ships are capable of High Frequency (HF) and Ultra High Frequency (UHF) Link 11 operations. Those ships that have the specific warfare mission of controlling

interceptor aircraft are able to operate several different Link 4A connections while conducting Link 11 operations. Most ships that are fully Link 11 capable also have the capability to broadcast and receive Link 14. [Ref. 26:p. 57-58]

c. *Connectivity*

Connectivity of the NTDS and its various Links has become an increasing concern with regards to joint operations. The Navy's Link 11 is a capable system compared to other military data exchange systems. However, it is not interoperable with other major US or NATO systems such as TADIL-B and Link 1 used in the NATO Air Defense Ground Environment (NADGE) C^3 system. This has led to many interoperability problems between the Armed Forces. The most noticeable test of this C^3 systems interoperability with C^3 systems of the US military came during Operation DESERT STORM. Figure 13 shows the connectivity Links between several C^3 systems fielded to the area. It should be noted that if it were not for the Marine Corps and its TADIL-B/Link 11 gateway capability, the Navy would not have been integrated with Army and most of the Air Force's systems. [Ref. 28]

4. Procedures and Personnel

The procedures and personnel involved with any C^3 system are key components of its process. It is critical that the operators receive the same type training and use the same procedures while carrying out the process of the system.

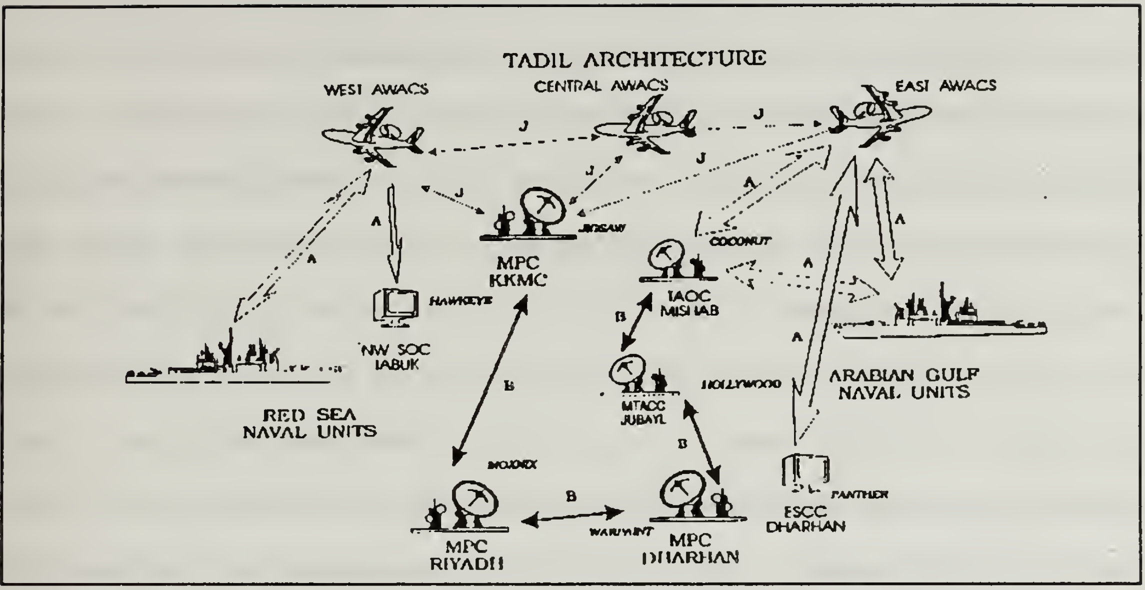


Figure 13 Desert Storm TADIL Architecture [Ref. 28]

While each of the Armed Forces conduct integrated training programs within their own communities, they do not train to the same procedures. An example of this is a comparison of Navy and Marine Corps Link procedures. Even though these two services frequently operate together, they do not always use the same procedures for maintaining a Link.

Navy Link procedures call for the use of "X-ray" codes frequently while conducting Link operations [Ref. 25:p. 3-5]. The Marines rarely use "X-ray" codes for Link operations. Navy personnel within the NTDS system are rarely trained as technicians for the Link system and are normally trained only in the procedures of its use [Ref. 26:pp. 1-1 - 1-4]. Marines are now trained as both operators and technicians. Marine operators are responsible for initiating and maintaining all

Link operations. Technicians no longer set up the Link and hand it over to the operators when operational. Most Navy operators do not understand the technically-related issues concerning the setup and conduct of Link operations. As a result, Marine operators are forced to talk operational AAW matters over the AAW coordination and reporting (AAW C&R) radio voice network and switch to the Link coordination and reporting (Link C&R) radio voice network to discuss technical problems at the same time. The Navy, meanwhile, has a separate person on each of the nets operating simultaneously. These differences have caused considerable delays and confusion in Link coordination between the two Services.

C. AIRBORNE TACTICAL DATA SYSTEM (ATDS)

The Airborne Tactical Data System (ATDS) is a system that is comparable with the NTDS designed for use aboard aircraft. The ATDS specification was issued in 1955, but there was no computer system available at that time to meet its requirements [Ref. 23:p. 105]. A surveillance aircraft's ATDS does not have to include the capabilities of integrating several different onboard weapon systems like its NTDS counterpart. This alone allowed for substantial savings in space and weight required of the ATDS. It was not until the late-1960's when the E-2A HAWKEYE squadron deployments began, that an ATDS system was routinely used in Link operations with the fleet. Its estimated ability to maintain 250 tracks and

control 30 interceptions was several orders of magnitude greater than the system that it replaced [Ref. 23:p. 106]. The E-1B and its manual airborne CIC plots could maintain 4-6 tracks and could control only two simultaneous interceptions using voice control. ATDS and its automatic data link have made this system a true force multiplier. [Ref. 29:pp. 145-147]

1. Aircraft

a. E-2 HAWKEYE

The E-2 HAWKEYE was designed from the beginning as an Airborne Early Warning (AEW) platform. The prototype first flew in October of 1960 and introduced the concept of a giant rotodome radar rotating on a pylon above the aircraft's fuselage to enable 360 degree coverage [Ref.30:p. 93]. The HAWKEYE also carries an Electronic Support Measures (ESM) system that allows passive detections of radar emissions. The E-2 has been produced in three versions; E-2A, E-2B and E-2C. In addition to these versions of the aircraft, the radar has been modified and changed numerous times. To date, the E-2 has operated the APS-96, APS-120, APS-125, APS-138, and APS-139 air search radars. The most current version of the HAWKEYE is the E-2C with the APS-139 radar. [Ref. 23:pp. 374-376]

(1) Sensors. The sensors of the E-2C, are its main assets. The APS-139 3D air search radar can provide detection out to 300 miles. The combined capabilities of the APS-139, ATDS and Link 4A allow this airborne CIC to maintain over 2,000 air and surface tracks and control more than 40 air intercepts. The ALR-67 allows passive detection of radar emission over 600 miles from the emitter. This passive detection system can also be integrated with the ATDS to allow force dissemination of possible hostile radar emissions and greatly aids in target localization by ESM. [Ref. 23:pp. 374-376]

(2) Connectivity. The E-2C and its ATDS is capable of HF or UHF Link 11 operations concurrent with several Link 4A operations. Unfortunately, it is not interoperable with TADIL-B, Link 1 or Link 16, which are discussed in above. This AEW aircraft can also operate several UHF radio voice nets for C&R with other assets participating in the different Links. [Ref. 31:pp. 1-41 - 1-42]

b. E-3 SENTRY

Although the E-3 SENTRY is an Air Force asset, it is well known for its Nearland/Overland Antiair Warfare (NOAAW) capabilities. The SENTRY is better known as the Airborne Warning and Control System (AWACS). The AWACS is considered a strategic asset as it was designed primarily to

provide contingency continental air defense during nuclear attack [Ref. 2:p. 86]. Over the years however, it has been used mostly for its tactical C^3 system capabilities in US military operations around the world. It is such a valuable asset that its mere presence in an area is an automatic "tipper" that a military operation is underway.

(1) Sensors. The APY-1 air search radar is the main sensor for the earlier versions of the E-3. Aircraft after number 25 and upgrades of the earlier production aircraft have received the APY-2 system which has a maritime surveillance capability. These are E/F Band radar systems that can function in seven different modes of operation. These seven different modes allow the E-3 SENTRY to be an excellent surveillance platform in the Nearland/Overland AAW (NOAAW) scenario even in a heavy jamming environment. The rotodome is rotated at six RPM when the radar is operational and its scan is mechanical in azimuth and electronical from the ground to the stratosphere. [Ref. 32:p. 365]

(2) Connectivity. The E-3 SENTRY is well known for its connectivity. It is capable of TADIL-A, TADIL-C and TADIL-J operations at the same time. It has an extensive communications suite that allows it to operate numerous radio voice nets for C&R with other assets. [Ref. 32:p. 365]

c. *S-3 VIKING and P-3 ORION*

The VIKING and Orion are primarily Antisubmarine Warfare (ASW) and Antisurface Warfare (ASUW) aircraft. They both carry an ATDS with Link 11 capability. This Link capability is provided primarily for scouting ahead of a force for surface and subsurface contacts and coordinating attacks and does not provide timely AAW information. It is hoped that these platforms can coordinate an attack on missile carrying submarines and surface vessels before they can launch their missiles. [Ref. 30:pp. 90-91]

D. COMBAT DIRECTION SYSTEM (CDS)

CDS was designed to meet two criteria. The first was to provide a greatly improved NTDS type system for the TICONDEROGA class AEGIS ships [Ref. 23:p. 85]. Secondly it was also to be the system that replaced NTDS in ships that were to receive New Threat Upgrade (NTU) modifications [Ref.29:p. 145]. The system was to reduce the number of computers, increase reliability, replace analog systems where feasible and economical, and automate as many functions within the system as possible. [Ref. 23:p. 85]

1. Facilities

The CDS is installed on the earlier series of TICONDEROGA class cruisers and all ships that have received NTU modifications. This is an interim system for the TICONDEROGA class. It is eventually to be replaced by the

Advanced Combat Direction Center (ACDS). Due to the reduced military budget of the 1990's, it is unlikely that the NTU ships will receive the complete upgrade to ACDS capability. ACDS is discussed in Chapter VII. [Ref. 23:p. 85]

2. Equipment

The equipment within this system is designed primarily to eliminate the translators between an analog and digital system by replacing most analog systems with digital versions that can directly exchange information with CDS. This has occurred mainly with the weapon systems. Automation is greatly enhanced with the use of SYS-2 Integrated Automatic Detection and Tracking (IADT). IADT eliminates human entry of tracks into the system and instead allows them to manage the flow of tracks created by the search radars. The SYS-2 system also integrates the data received by the search radars and produces a single radar picture [Ref. 23:p. 354]. The design of the overall system allows for any one connection of a ship's Weapons Direction System (WDS), CDS and IADT triangle to be eliminated while the other two continue to operate together (See Figure 14). [Ref. 32:p. 36]

CDS alone allows for a vast improvement in the display of tactical data. Automated Status Boards (ASTABS) have replaced manually updated status boards with information received directly from CDS. Additionally, Large Screen Displays (LSDs) have been added to enhance the ability of a

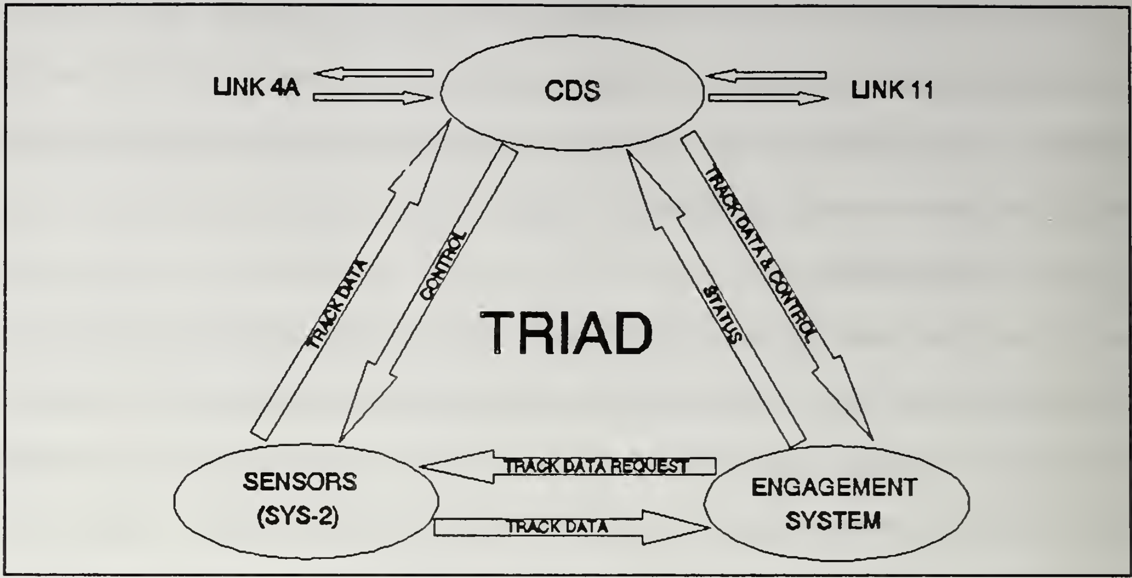


Figure 14 CDS Triad Design [Ref. 33:p. 37]

commander to see and comprehend the tactical data displayed by CDS. The LSD is essentially a large screen television that replaces the conventional console display. [Ref. 23:p. 83]

3. Communications

Although CDS is a vast improvement over NTDS, it does not improve upon any of the communication Links. Ships that have CDS can still operate a Link 11 system simultaneously with several Link 4A operations. However, they are still not interoperable with the other major data exchange systems of the US military and NATO.

E. MARINE AIR COMMAND AND CONTROL SYSTEM (MACCS)

The Marine Air-Ground Task Force (MAGTF) requires close coordination between air and ground units. The Aviation

Combat Element (ACE) commander exercises command and control via the MACCS. The MACCS is composed of a variety of agencies that provide near real time information that allow the ACE commander acting as the Tactical Air Commander (TAC) and subordinate commanders to make sound tactical decisions. [Ref. 16:p. 1-1]

Figure 15 depicts the organization of the agencies that are under the command of the Marine Aircraft Wing that provide the MACCS with its AAW assets. [Ref. 7:p. 2-8]

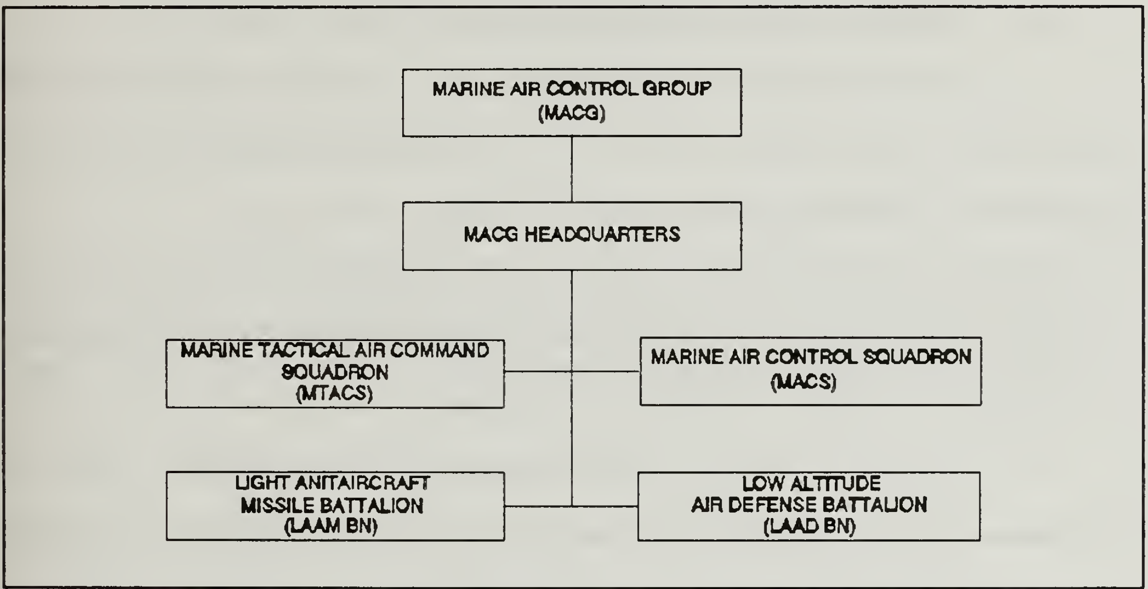


Figure 15 MACG AAW Agencies [Ref. 15:p. 2-6]

F. MARINE AIR CONTROL GROUP (MACG)

The MACG is the subordinate element of the Marine Aircraft Wing (MAW) that provides all the agencies that form the MACCS. The mission of the MACG is to coordinate the air command and

control systems of the MAW. It is commanded by a Colonel. [Ref. 16:p. 2-9]

The Headquarters and Headquarters Squadron (H&HS) provides the administrative and maintenance support for the MACG headquarters. It is commanded by a Lieutenant Colonel and provides the personnel that operate the Tactical Air Command Center (TACC) [Ref. 16:p. 1-2]. The H&HS will soon be redesignated as the Marine Tactical Air Command Squadron (MTACS) [Ref. 15:p. 2-6].

1. Tactical Air Command Center (TACC) Ashore

The TACC is the primary air control agency of the Amphibious Task Force (ATF). It is also the senior agency of the MACCS. [Ref. 16:pp. 1-1 - 2-1]

> It is the facility from which the TAC and ACE battle staff can supervise, coordinate and execute all current and future tactical air operations over the MAGTF's airspace and coordinate organic aviation with that of other services. [Ref. 16:pp. 1-1 - 2-1]

The TACC is a major player in the MACCS. The TACC provides the facilities for the TAC to direct, control, coordinate and supervise all MAGTF tactical air operations. The TACC is equipped with the communications and data link necessary to gather and disseminate information that may affect the conduct of tactical air operations. [Ref. 34:p. 2]

The TACC in executing its duties is responsible for the following:

- Maintaining accurate and up to date information on the air situation including ground combat information essential to the air effort.

- Managing all aircraft in the objective area to ensure the most balanced and effective utilization of assets for tactical air operations.

- Supervising the operations of subordinate MACCS agencies to preserve economy and unity of effort in the execution of the TAC's air plans.

- Prescribing succession of command and control responsibilities with the MACCS and to compensate for any serious degradation within a component agency. [Ref.33:p. 3]

The TACC is divided into the plans section and the operations section.

a. Plans Section

The plans section is manned by elements from the MAW and is responsible for allocating assets and publishing the daily Air Tasking Order (ATO). The most important elements of the plans section is the G-2 (Intelligence) and the G-3 (Operations) because they provide the TAC with the most current intelligence and with that intelligence construct the ATO. [Ref. 34:p. 4]

b. Operations Section

The operations section is run by the Senior Air Coordinator (SAC). The SAC is responsible to the TAC for the operation of the TACC. Once the ATO is published, the operations section is responsible for its distribution to all the required MACCS agencies. Once the ATO is distributed, the

operations section is responsible for its execution or any other fragmentary orders. The operations section also provides the TAC with a digital display of the air war. [Ref. 34:p. 4]

2. TACC Equipment

The TACC consists of two major equipment groups, the AN/TYQ-1 and the AN/TYQ-3A.

a. *AN/TYQ-1*

The AN/TYQ-1 provides the work space for the TACC personnel. The SAC and his staff operate from this shelter. It houses the automated displays and communications. The shelter is made of rubber and held up by forced air which is why it is often referred to as "the bubble". The AN/TYQ-1 consist of three equipment groups, the AN/TYA-1 operations group, the AN/TYA-3 planning group and the AN/TYA-16A communications group. [Ref. 34:p. XIII-5]

The AN/TYA-1 is the bubble that houses five Situation Display Consoles (SDC), ten Communications Control Units (CCU), a Weapons Availability Status Display (WASD), and various status and plotting boards. [Ref. 34:p. XIII-5]

The AN/TYA-3 is the bubble that houses the plans personnel, the command console which controls the command display, six CCU's and several status and plotting boards. The TAC will reside in this bubble. [Ref. 34:p. XIII-17]

The AN/TYA-16A provides all terminal and control facilities required for the TACC. [Ref. 34:p. XIII-18]

b. AN/TYQ-3A Tactical Data Communication Central

The AN/TYQ-3A provides tactical data communications for the TACC. The TDCC provides the means to conduct data link operations such as HF or UHF Tactical Data Information Link-A (TADIL-A). It has ten TADIL-B/Army Tactical Data link (ATDL-1) of which two may be Nato Air Defense Ground Environment (NADGE) link-1 and one TADIL-C, also known as Link-4A. The TDCC can interface and translate information among links such as NADGE and TADIL-A and/or TADIL-B. The TDCC can also provide secure HF and UHF voice communications. [Ref. 34:p. VIII-20]

G. MARINE AIR CONTROL SQUADRON (MACS)

The MACS provides air surveillance and control of aircraft and surface to air weapons for antiair warfare in support of the Fleet Marine Force (FMF). The MACS provides this support via the employment of the Tactical Air Operations Center (TAOC) and the Early Warning and Control (EW/C) site. [Ref. 16:p. 1-2]

1. AN/TYQ-2 Tactical Air Operation Center

The TAOC provides the necessary equipment for air surveillance and control of aircraft and missiles. Radars and computerized equipment provide the means for air surveillance, Ground Controlled Intercepts (GCI) and air traffic control.

Control of missiles is performed via voice communications and tactical data link. [Ref. 34:p. I-2]

The mission of the TAOC is as follows:

> The mission of the TAOC is to detect, identify and control the intercept of hostile aircraft and missiles; provide airspace management and navigational assistance to friendly aircraft, and function as the alternate TACC when directed. [Ref. 16:p. 3-1]

The TAOC performs its mission via the conduct of the following operational functions:

- target detection, acquisition and tracking;
- target identification and classification;
- threat evaluation and weapons assignments;
- interceptor control;
- surface to air missile control;
- data communications. [Ref. 34:p. I-2]

These operational functions are achieved by dividing the TAOC into three operational sections. These sections include the weapons, surveillance and traffic sections.

a. Weapons Section

The weapons section is responsible for threat evaluation, threat assignments and the engagement process which includes the controlling of interceptor aircraft and HAWK missile batteries. The weapons section is also responsible for maintaining the status of weapons resources and the progress of engagements. [Ref. 34:p. IX - 3-4]

b. Surveillance Section

The Surveillance section is responsible for the detection, acquisition and identification of all known targets within the designated air defense sector. The surveillance section includes electronic warfare and data link as part of its operational functions. [Ref. 34:p. IX-4]

c. Traffic Section

The traffic section is responsible for the control of friendly aircraft. All fixed wing aircraft or aircraft not under control of another agency transiting the air defense sector will process through the TAOC. The traffic section will normally provide an abbreviated situation report or any other pertinent information prior to vectoring the aircraft to proceed with its mission or handing over the aircraft to another control agency if necessary. [Ref. 34:p. IX - 4-5]

2. AN/TYQ-2 TAOC Equipment

AN/TYQ-2 consists of two associated equipment groups and eight main equipment groups. Five of the main equipment groups are operational groups and will be described in this section. The other three, namely the AN/TYA-23, AN/TYA-27, and the AN/TYA-25, are used as maintenance facilities and will not be discussed. [Ref. 34:p. I-2]

a. AN/TYA-5 Central Computer Group

The AN/TYA-5 contains the main memory and associated logic units for the TAOC automated features that

include automatic tracking, generation of interceptor vectoring instructions, stored data processing for console display and processing of digital data exchange. [Ref. 34:p. I - 2-3]

b. AN/TYA-18 Dimensional Radar Processor Group

The AN/TYA-18 provides two Radar IFF Data Processors (RDIP), one three dimensional RIDP and one two dimensional RIDP. The RIDP is responsible for automatic target detection and location. It is also responsible for decoding and presentation of IFF video. This information is sent to the AN/TYA-5 which is used to initiate a track or update an existing track. [Ref. 34:p. I-3]

c. AN/TYA-9A Operator Group

The AN/TYA-9A provides the facilities for operators to control aircraft, make assignments to missile batteries and monitor the air picture. It houses three universal operator consoles and four operator communication panels. There are three AN/TYA-9A's in a AN/TYQ-2 TAOC. [Ref. 34:p. I-3]

d. AN/TYA-9B Supervisory Operator Group (SOG)

The AN/TYA-9B consists of a modified AN/TYA-9A and two TYA-9B senior air director facilities. The TYA-9Bs are expandable shelters that provide facilities for monitoring and coordinating TAOC communications and maintaining several manually plotted status boards. [Ref. 34:p. I-4]

e. AN/TYA-12 Communications Group

The AN/TYA-12 is the facility that provides connectivity for internal and external communications. The following communications are routed via the AN/TYA-12:

- missile battery data link;
- ground air ground data link;
- UHF voice communications;
- teletype communications;
- HF/radio relay voice communications;
- multidestination and single destination nets. [Ref. 34:p. I-4]

The AN/TYA-12 also contains an 80 link switchboard which can be used for additional internal and external communications. [Ref. 34:p. I-4]

3. AN/TYQ-2 Associated Equipment Group

a. AN/TYA-11 Communications Central Group

The AN/TYA-11 provides five AN/GRC-171 UHF radios for aircraft control. Three of these radios may be channelized from the AN/TYQ-9A operator group. The TAOC normally employs two AN/TYA-11's. [Ref. 34:p. I-5]

b. AN/TYQ-3A Tactical Data Communication Central (TDCC)

The AN/TYQ-3A provides tactical data communications for the TAOC. It is the same equipment used by the TACC. The TDCC provides the means to conduct data link

operations such as HF or UHF Tactical Data Information Link-A (TADIL-A), ten TADIL-B/Army Tactical Data link (ATDL-1) of which two may be Nato Air Defense Ground Environment (NADGE) link-1 and one TADIL-C, also known as Link-4A. The TDCC can interface and translate information among links such as NADGE and TADIL-A and/or TADIL-B. The TDCC can also provide secure HF and UHF voice communications. [Ref. 34:p. I-5]

H. LIGHT ANTIAIRCRAFT MISSILE BATTALION (LAAM BN)

The LAAM BN provides medium range surface to air missile defense for the MAGTF via the employment of Homing All the Way Killer (HAWK) missiles against low and medium altitude air attacks. Its command and control facility is the Battery Command Post (BCP). HAWK is discussed in Chapter V. It is commanded by a Lieutenant Colonel. [Ref. 16:p. 1-2]

I. LOW ALTITUDE AIR DEFENSE BATTALION (LAAD BN)

Although the LAAD BN is not considered a C^3 system, it is part of the overall MACCS and will be discussed in this chapter. The LAAD BN provides close in air defense protection for the MAGTF via the employment of the STINGER missile system. When employed in forward combat areas, particularly in areas not defendable by other elements of the antiair warfare system, its mission is to destroy hostile aircraft and unmanned aerial vehicles. [Ref. 16:p. 1-3]

J. SUMMARY

C^3 systems provide the means and the connectivity through which the services conduct AAW. The following chapter provides a description of weapon systems that commanders employ via the C^3 systems described earlier to conduct AAW.

V. CURRENT WEAPON SYSTEMS

A. AIRBORNE WEAPON SYSTEMS

Since World War I (WW I) the aircraft has been the main Antiair Warfare (AAW) weapon system. Over the years aircraft capabilities and weapons have improved to the point that air targets can be engaged beyond visual range with weapons of high destructive power. This section gives a general description of the sensors, weapon systems and the connectivity capabilities of AAW platforms currently available in the USN and USMC inventories.

1. F-14 TOMCAT

The F-14 is the Navy's current fleet air defense interceptor. The TOMCAT was designed from the beginning to carry the AWG-9/PHOENIX AAW weapon system and variable geometry wings to increase the envelope and performance of the aircraft in the outer air battle around the aircraft carrier. Production of the F-14A ended in April of 1987 after 545 aircraft had been produced. [Ref. 30:p. 91]

In the mid 1980's a two-prong upgrade program for the F-14A began. These upgrades were to improve performance of the jet engines and replace most of the analog avionics suite with digital systems. This approach led to two new variants of the F-14, the F-14A+ (later redesignated the F-14B) and the

F-14D. Due to the reduction of the DOD budget following the breakup of the Warsaw Pact and the dissolving of the USSR, plans to remanufacture the majority of F-14A aircraft into F-14Ds have been shelved. It is planned to have the F-14 replaced sometime after the turn of the century by the F/A-18E/F for fleet air defense. [Ref. 30:p. 91]

a. F-14A

Powered by two Pratt and Whitney TF30-P-412A or -414A turbofans rated at 20,900 lb static thrust each, the F-14A is capable of 912 mph at low altitudes and 1,544 mph at altitude. It has a ceiling of 50,000 ft and a maximum range of 2,000 miles with external fuel tanks. [Ref. 30:p. 91]

(1) Sensors. The F-14A carries the AWG-9 fire control system which enables it to control PHOENIX and SPARROW missiles. It is an X-band radar that can track up to 24 targets simultaneously. The AWG-9 is capable of guiding six PHOENIX missiles against six separate targets. In non-jamming environments it is capable of limited tracking of targets up to 115 nm. [Ref. 23:p. 376]

(2) Connectivity. The TOMCAT is capable of sending and receiving Tactical Data Information Link-C (TADIL-C). The Link can be such that it is either a one way or two way Link between the aircraft and the controlling platform. It also carries several Ultra High Frequency (UHF) and Very

High Frequency (VHF) radios for voice communications. [Ref. 31:pp. 1-52 - 1-57]

(3) Weapons. The weapons on the F-14A are the PHOENIX, SPARROW and SIDEWINDER Air-to-Air Missiles (AAMs) and a 20MM gatling gun which enable it to engage hostile aircraft or missiles. Four SPARROW or PHOENIX missiles can be carried semi-recessed under the fuselage. Pylons under the wing root section can carry various combinations of the three different missiles. [Ref. 30:p. 91]

b. F-14B

Formerly known as the F-14A+, this version of the F-14 features upgraded engines while retaining the analog avionics of the F-14A. The two General Electric F110-GE-400 engines provide additional thrust, much increased operational reliability and reduced fuel consumption. These new engines also allow for non-afterburner catapult launch of the aircraft which reduces tanking requirements. A total of 70 F-14Bs have been acquired with 38 new construction and 32 rebuilt F-14A aircraft. The F-14B maintains the original capabilities of the F-14A with regard to sensors, connectivity, and weapons. [Ref. 30:p. 91]

2. FA-18 HORNET

a. F/A-18A/B

The F/A-18A is a single seat multi-role fighter aircraft which replaced the F-4 in the fighter role and the A-

7 in the attack role. The F/A-18B is a combat capable tandem two seat version of the F/A-18A used for training. The F/A-18B also has 6% less fuel capacity than the F/A-18A. The challenge of the F-18 was optimizing a design which would provide fairly equal capability in both the fighter and attack role. The F-18 is a versatile aircraft that provides excellent maneuverability for air to air engagements. Its major disadvantage is that it has a short combat radius when compared to other U.S. tactical fighters such as the Navy F-14 or the Air Force F-15. The F-18 is equally well suited for its attack role with a theoretical maximum load of 17,000 lbs, although in practice the loads are much smaller. [Ref. 35]

(1) Sensors. The F-18 employs the APG-65 multi-mode radar which is able to track ten targets and display eight. The cockpit of the F-18 is claimed to be one of the most advanced with three Kaiser Cathode Ray Tube (CRT) displays which can be used simultaneously. The F-18 also employs an advanced Heads Up Display (HUD). [Ref. 35]

(2) Connectivity. The F-18 is data link capable employing two way TADIL-C. It is also VHF and UHF voice capable. [Ref. 32:p. 439]

(3) Weapons. The F-18 has nine external weapons stations. It has fuselage mounted SPARROWS for its fighter role with Forward Looking Infrared (FLIR) and a laser tracker for its attack role. The wingtip stations are used for

Sidewinders for air to air engagements. An M61 20 mm six barrel gun with approximately 570 rounds is mounted in the nose of the F-18. The F-18 is an excellent AAW platform. [Ref. 32:p. 439]

b. F/A-18C/D

This version of the F-18 was first purchased in 1986. The F/A-18C/D still employs the multi-role air to air and air to ground APG-65 tracking radar. The F/A-18C/D is data link capable employing two way TADIL-C. The F/A-18D is the two seat version of the F-18C. [Ref. 32:p. 439]

(1) Weapons. The F/A-18C/D are similar to the F/A-18A/B but have provisions for up to six Advanced Medium Range AAM (AMRAAM) weapons, two fuselage mounted and two on each outboard wing station. It can also carry up to four imaging infra-red Maverick missiles. It has provisions for the AN/ALQ-165 airborne self protection jammer which is interchangeable with the AN/ALQ-126B. Aircraft avionics has also been upgraded. They also have the AN/AAR-50 FLIR Thermal Imaging Navigation Set (TINS) which present TV like images on the Kaiser AN/AVQ-28 raster heads-up display. They also include multi-color displays and a color digital moving map system. [Ref. 32:p. 437]

3. HARRIER II AV-8B

The AV-8B is the premier high speed, low altitude flying, night attack capable aircraft that the Marines use for

close air support. It is an extremely versatile aircraft that provides flexibility for the U.S. Marine Corps. The AV-8B can take off or land on the decks of amphibious assault ships, roads, clearing in the woods or even bomb damaged runways. [Ref. 36]

As of late 1990, the AV-8B has been retrofitted with the new 408 engine which provides 23,400 lbs of thrust as opposed to the Rolls-Royce Pegasus engine which provided 21,450 lbs of thrust. The 408 also provides twice the time between overhauls of engines (1,000 hours). [Ref. 36]

In addition to the advantage provided by the AV-8B ability of short take off and vertical landing (STO/VL), which eliminates the need for long runways, the AV-8B also requires less ground support than other tactical fighters. The AV-8B starts from internal power which eliminates the need for engine-starting carts which are bulky and take up valuable deck space, especially aboard smaller ships. [Ref. 35]

The AV-8B has proved to be an extremely effective aircraft in its close air support but has not been exploited in an AAW role. Although limited by its on-station time and air to air weapons load out of four SIDEWINDERS, the AV-8B is an excellent platform for use in a point defense role. The AV-8B is an excellent platform for close-in engagements. It has the ability to vector thrust while in forward flight which allows the aircraft to perform maneuvers that are impossible for other fighter aircraft to perform. The AV-8B can use

tactics such as decelerating extremely quickly which will likely cause a threat aircraft to overshoot or fly past it while conducting an air to air engagement. [Ref. 36]

4. EA-6B PROWLER

The EA-6B PROWLER is the stand-off and penetration jammer for the fleet. It took to the air on May 25, 1968 and was the first aircraft in the world to be designed from the beginning for Electronic Warfare (EW) and active Electronic Countermeasure (ECM). It was preceded by the EA-6A, but the A version was an interim solution based on the two-man crew A-6 airframe and retained a limited weapons carrying capability. The B version has a crew of four (pilot and three ECM officers) and has two Pratt and Whitney J52-P-408 turbojets that provide 11,200 lbs static thrust each. It has a maximum speed of 610 mph at sea level with a service ceiling of 38,000 ft and a range of 1,100 nm with 5 ECM pods. A total of 149 EA-6Bs have been ordered, of which 139 have been delivered as of late 1990. The PROWLER is only capable of "soft kill" jamming of airborne threats. [Ref. 30:p. 93]

The EA-6B initially was void of all weapons-carrying capability. Over the years the EA-6B has received various upgrades to its ESM and ECM equipment. These upgrades started with the Expanded Capability (XCAP) program in 1973, followed by the Improved Capability program starting in 1977 (ICAP I and ICAP II) and the Block '86 program of 1988, and have all

now reached fleet. ICAP II and Block '86 provide the PROWLER the capability to fire HARM Anti-Radiation Missiles (ARMs). The Advanced Capability program (ADVCAP) is currently beginning its test and evaluation phase and is covered in Chapter VIII. [Ref. 23:p. 215]

a. Sensors

The EA-6B carries the elaborate ALQ-99 tactical support jamming system. The main group of receiving antennas for this system is located in a large bulge on top of the tail, giving the PROWLER a very distinctive look. The ALQ-99 system has a series of receiver antennas and signal processors that feed a central computer with integrated displays and jammer controls. The system allows for automatic control, if desired, of the jamming pods by the computer. [Ref.23:p. 215]

b. Connectivity

The PROWLER has no Link capability. It has only UHF and VHF radios to relay information by voice procedures. [Ref. 31:pp. 1-22 - 1-23]

c. Weapons

The EA-6B can counter missiles with active jamming by the ALQ-99 jamming pods. All versions are capable of carrying up to five different jamming pods. However, two pods are normally replaced by fuel tanks to increase endurance. Each pod is limited to a specific bandwidth of the threat spectrum. [Ref. 23:p. 215]

5. Airborne Weapons

Aircraft are normally the preferred means of engaging hostile tracks at a safe distance from the battle group. Since WW I, airborne weapons have continually been improved in an effort to increase their range and lethality. We have progressed from the hand guided bricks of the early days of WW I to the modern semi-active radar-homing air to air missile. These missiles can provide a standoff engagement capability, depending on the threat, and have become the main means for engagement for fighter aircraft. Guns, however, are carried by all modern fighters for a close-in kill capability.

a. Air-to-Air Missiles (AAMs)

(1) AIM-54 PHOENIX. The PHOENIX is the longest range air to air missile in operation with US forces. It is used only by the F-14 TOMCAT. The missile receives data from the AWG-9 fire control system prior to launch that allows it to fly to the general vicinity of the target. An onboard auto pilot allows the missile to fly the most efficient flight profile to the target location. Once in the area the PHOENIX receives semi-active illumination from the AWG-9 fire control radar to make last second corrections to intercept the target. Terminal homing is provided by the missile's own X band active seeker. The AIM-54C+ has a range greater than 85 nm and can engage targets up to 100,000 ft. It has a 133 lb warhead and can fly at speeds up to Mach 5. [Ref. 23:p. 418]

(2) AIM-7 SPARROW. SPARROW was the West's first radar homing AAM with its design beginning in May of 1946. Ten years later, the first production version of the AIM-7 missile (AIM-7A) entered the fleet. By the end of 1962, 2000 missiles had been produced. The SPARROW is a semi-active missile. The AIM-7 missile has gone through numerous upgrades since the A version. Unlike the PHOENIX, all versions prior to the AIM-7M require illumination by an aircraft's fire control radar for launching, tracking, and intercept. The AIM-7M has an auto pilot giving it a range of approximately 24 nm and a speed of Mach 4 with an 86 lb warhead. [Ref. 23:p. 425]

(3) AIM-9 SIDEWINDER. The SIDEWINDER missile is guided by passive infrared emissions from a target. The first missile flew in September of 1953. The most current version of the SIDEWINDER is the AIM-9M, which is an all-aspect AAM. Prior to the AIM-9L version, the SIDEWINDER was limited to rear hemisphere attacks. The SIDEWINDER has a range of approximately 20,000 yds carrying a 25 lb warhead at Mach 2.5. [Ref. 23:p. 421]

b. Guns

(1) M61A1 VULCAN. The VULCAN 20MM gatling gun is the prime gunnery air to air close-in weapon. All fighter aircraft of the US Navy carry a version of this gun. It has

a firing rate of 4,000 or 6,000 rounds per minute with a 570 round magazine capability. [Ref. 23:p. 200]

B. SHIP BASED AAW SYSTEMS

During WW II naval combatants grew to become powerful air defense weapon systems. Initially, the light caliber rapid firing guns were the main defense against air targets, such as kamikazes, that made it past the Combat Air Patrol (CAP). As missile technology developed after the war, Surface-to-Air Missiles (SAMs) became the prime shipboard weapon against air targets. Their stand-off engagement and destructive power became ever important with the increasing air threat capabilities. [Ref. 29:pp. 142-144]

This section provides a general discussion of the major sensor and weapon systems onboard classes of USN warships and the connectivity capabilities of USN warships. These systems are covered because each forms a vital subsystem within the Naval Tactical Data System (NTDS) C^3 system of a warship. Several systems are not included. These systems are in classes of ships that are due to be decommissioned, have extremely limited capability, and/or are inappropriate for this topic. The class of ships not covered are: aircraft carriers, auxiliaries, classes that are due to be decommissioned by 1994 (KNOX, COONTZ, CHARLES F. ADAMS, TRUXTON, etc.), and amphibious ships.

1. Ship Surveillance systems

Most USN warships have several different systems for detecting aircraft. The most common systems are air search radars. There are two types of air search radar systems. They are two (2D) and three (3D) dimensional systems. 2D radars provide only bearing and range information on an air track. 3D radars provide bearing, range and height information. Surface search radars have been proven to be adequate systems for detecting low flying aircraft at short range. Since these systems are not designed for detecting aircraft they are not discussed in this paper. [Ref. 33:p. 9]

EW systems can also provide important early warning of hostile aircraft and missiles. Most Electronic Warfare (EW) systems provide an Electronic Support Measures (ESM) capability in detecting emissions from aircraft and missile radars. These systems are usually limited in the frequency range they can monitor and are only now being automatically integrated into the tactical data systems of US warships. [Ref. 23:p. 475]

a. *SPS-48*

The SPS-48 series radar systems provide height, bearing and range information on airborne targets. It is the most sophisticated 3D frequency scanning rotating air search radar on US warships. This S-band radar scans multiple beams in elevation to combine long range with high data rate and

multiple pulses to increase probability of detection in jamming environments. The antenna is electronically stabilized against pitch and roll up to 20 degrees. It provides detection out to 220 nm and up to 100,000 ft. The maximum elevation angle is limited to 45 degrees except for the SPS-48E version which provides coverage up to 65 degrees elevation. The 45 degree limit does cause a considerable blind zone immediately above the ship. Several cruise missiles are designed to take advantage of this blind zone. [Ref. 23:pp. 332-333]

b. SPS-49

The SPS-49 2D radar provides secondary air target data for most guided missile ships. They are long range, early warning L-band radars. The system is capable of providing detections out to 250 nm and has become the standard 2D radar for the USN. [Ref. 33:p. 9]

> The SPS-49 radar set achieves excellent performance in the presence of severe land and weather clutter, and active electronic countermeasures and chaff, by means of adaptive digital Moving Target Indicator (MTI) techniques, selectable pulse repetition frequencies, high transmitting pulse energy (through pulse compression), narrow antenna beamwidth, frequency agility, coherent sidelobe cancellation, constant false alarm rate (CFAR), and other anti-jamming circuitry. [Ref. 36:p. 36]

c. SPS-40

The SPS-40 is an older series of air search radar and has only marginal capability in a jamming environment. This L band radar system is a compromise between very long

range (achieved by using low frequency) and reasonable definition. Later versions of the SPS-40 have a Low Flyer Detection Mode (LFDM), digital MTI (DMTI) and an Automatic Target Detector (ATD) that allows automatic integration with a ship's tactical data system. The SPS-40 is being replaced by the SPS-49 as the primary 2D air search radar for the USN. [Ref. 23:p. 332]

d. AEGIS

All AEGIS ships carry four phased-array SPY-1 3D radars. Each array is a 12 ft by 12 ft octagon with 140 array modules. Each module contains 32 radiating elements driven by eight transmitters. There is a slight overlap in coverage of each array's sector to ensure 360 degree coverage. This S band radar system provides virtually continuous updates of all tracks due to dipole radiation to secure an electronic sweep versus actual radar rotation on other systems. The AEGIS system normally makes one horizon scan and 12 scans above the horizon every minute. SPY-1 can provide detection of aircraft out to approximately 200 nm and performs extremely well in a heavy jamming environment. [Ref. 23:pp. 337-338]

e. SLQ-32

The SLQ-32(V) series is the standard ship ESM and ECM system. As originally designed, it comes in three basic versions. SLQ-32(V)1 is installed on auxiliaries and amphibious ships. It provides radar warning on H through J

bands. It has no active ECM capability. All V1s are eventually to be upgraded to the V2 version. The SLQ-32(V)2 provides ESM for B through J bands and is installed on frigates and destroyers. This version also has no active ECM capabilities. SLQ-32(V)3 is described later in this Chapter. The SLQ-32 is of a modular design that allows for relatively easy (though very expensive) upgrading from one variant to the next. [Ref. 23:pp. 528-529]

2. Ship Weapons

a. Surface to Air Missiles (SAMs)

The 3 "T" programs generated the first SAMs to be used operationally by the Navy. The TALOS and TERRIER long range missiles were destined to serve aboard larger ships due to their size. The TARTAR short range missiles were fitted primarily aboard frigates and destroyers. It was proven to be very expensive to operate three separate missile systems that were designed to do the same thing. Because of this, it was decided to create a "standard" missile that had the best features of all three "T" missiles. The missile is called STANDARD. It is made in two versions, Medium Range (MR) and Extended Range (ER). The MR has replaced the TARTAR and the ER has replaced the TERRIER. [Ref. 33:pp. 4-5]

(1) RIM-66 Standard Missile-MR. The original version of this family of missiles is the SM-1MR. The RIM-66B carries a 137 lb continuous rod warhead to maximum range of 25

nm and a maximum altitude of 80,000 ft. These are known as home-all-the-way missiles. They require illumination of the target from launch to interception. With these missiles they are always pointing towards the target and therefore are not kinematically efficient. Additionally, the continuous rod warhead combined with the target detection device that detonates the warhead tend to react too late for the smaller, faster moving air targets. The latest version of this SAM is the SM-1MR (BLK VI). [Ref. 23:pp. 401-402]

In order to improve on the major drawbacks of the SM-1 series the SM-2 series was developed. The SM-2 took the SM-1 airframe and modified several components in order to vastly improve its overall capabilities. Known as the RIM-66C, the SM-2MR has vastly increased capabilities. With an onboard auto-pilot and incorporated inertial navigation, the missile is flown out to the predicted point of interception of the target. This allows the missile to fly a much more efficient flight path. Since the missile can fly without target illumination, the aircraft is unaware that it is being targeted until the missile is in its terminal phase. The SM-2MR has a range of 45 nm. [Ref. 23:pp. 403-404]

Since the SM-2MR was developed it has been further modified in blocks (BLKs). SM-2MR (BLK I) has an improved mono-pulse seeker that helps counter self-screening jamming. SM-2MR (BLK II) carries an improved booster motor that greatly increases its kinematic envelope. The BLK II has

a range approaching 90 nm. It also carries a fragmentation warhead with a new Target Detection Device (TDD) that is designed for high closing speed intercepts. Future BLKs for the SM-2MR are discussed in Chapter VIII. [Ref. 23:p. 404]

(2) RIM-67 Standard Missile-ER. The ER missile has a high percentage of commonality with the airframe of the MR missile. The most visual difference is the large booster attached at the tail which greatly increases range and kinematic energy. The SM-1ER has a range of 45 nm and carries a 250 lb warhead at Mach 3. The RIM-67s have received the same modifications given to the MR as described above. SM-2ER is designated RIM-67B and has a range of 90 nm. SM-2ER (BLK II) has a range of approximately 115 nm. Future BLKs for the SM-2ER are described in Chapter VIII. [Ref. 23:pp. 403-404]

(3) RIM-7 SEA SPARROW. First developed in 1963 from the AIM-7E, the RIM-7H was designed to provide defense against low flying attackers. Modifications included rapid run up, folding wings and clipped tail fins. These were determined to be inadequate for the task. The RIM-7M is a AIM-7M with improved fuzing (adapting to low altitude clutter), and a self-destruct feature to prevent homing on friendly ships. An onboard auto pilot provides for a more efficient flight profile and kinematic energy to intercept the target. The range of the RIM-7M is up to 24 nm. [Ref. 23:pp. 424-425]

(4) FIM-92 STINGER. The STINGER missiles used aboard naval combatants are the exact same missiles used by the Marines. Specially trained detachments are normally embarked onboard ships on deployment to provide a STINGER capability. It is fully described in the Land Based Weapon Systems section.

b. Guns

Though no longer the main weapon for naval ships in AAW, guns still provide the last ditch effort to bring down close in targets. This is provided by small caliber rapid firing guns. Large caliber guns still provide a capability to engage low flying aircraft and helicopters at relatively moderate speeds. Large caliber guns are normally designated by diameter, caliber and Mark (design designation). An example would be the 5 inch 38 caliber Mark 30 which would be referred to as 5"/38 MK30. [Ref. 29:pp. 63-81]

(1) 5"/54 MK42. The 5"/54 MK42 was conceived as a single gun replacement for the venerable WW II twin 5"/38 gun mount. It achieved the same firing rate as the 5"/38 with a more powerful round. Initially capable of firing 40 rounds a minute, it had to be derated to 28 rounds per minute for safety reasons. It has a 40 round ready service drum that allows the rounds carried to be selectively loaded to fire the desired type of shell. It has a maximum range of just under

15 nm and requires a 13 man crew to operate the entire system. [Ref. 23:pp. 459-460]

(2) 5"/54 MK45. The MK45 is a slower firing gun mount that replaces the MK42. It fires 17 rounds per minute at a range slightly less than 15 nm. The MK45 has a single 20 round ready service drum and has an automatic fuse setter. It is capable of firing guided shells and has a much lower manning requirement than the MK42 as only six personnel are required to operate this gun system. Compared to the MK 42, the MK45 has a greatly simplified operating mechanism. The gun mount itself is completely unmanned. [Ref. 23:p. 460]

(3) 3"/62 MK76. The MK76 automatic gun has an extremely high rate of fire. Its 80 round ready service magazine provides 1 minute of sustained fire. Due to its size and fixed ammunition, it is unable to fire the more sophisticated types of shells as the five inch guns do. It takes three personnel to operate this unmanned gun mount. [Ref. 23:pp. 462-463]

(4) 20MM MK15 PHALANX. The PHALANX is the standard Navy Close-in Weapon System (CIWS) providing point defense. It fires 20 mm discarding sabot, depleted uranium penetrators designed to destroy or destabilize the missile's warhead, seeker, or airframe. It carries 999 rounds in a ready service drum immediately under the gatling gun. With a firing rate of 1,000 to 3,000 rounds per minute, it is only

capable of a few engagements before the ready service drum must be reloaded. The gun system is capable of fully autonomous operation against high speed closing air targets. [Ref. 23:p. 467]

The MK90 FCS is located above the gatling gun and provides a closed loop firing circuit. Once the mount begins to fire, the out-going rounds are tracked by the FCS. The gun mount is adjusted as necessary to ensure that the out going stream of bullets meet the incoming target. This system is very effective against low flying targets. [Ref. 23:p. 468]

c. Countermeasures

(1) SLQ-32(V). The SLQ-32(V) series is the standard USN ship EW system. As originally designed, it comes in three basic versions. SLQ-32(V)1 and 2 were described earlier. The SLQ-32(V)3 provides radar warning on B through J bands and jamming/deception on H through J bands. It has been found that the SLQ-32(V)1 and 2 are critically deficient with no active ECM capability. Several of the V2 systems have been upgraded with the SIDEKICK system to give them limited ECM capability. SIDEKICK and future upgrades of the SLQ-32 are covered in Chapter VIII. [Ref. 23:pp. 528-531]

(2) MK36 SRBOC Launcher. This six tube mortar is capable of launching chaff and flares or combined rounds to confuse radar and heat seeking Antiship Missiles (ASMs).

Ships normally carry a total of four launchers, with two on either side of the ship. Depending on the loading of the tubes and the type of threat, these four launchers can provide up to four separate salvos to deter ASM lock on. [Ref. 23:pp. 544-545]

(3) SLQ-49 RUBBER DUCK Decoy. This is the USN version of the British DLF floating decoys. They are essentially floating rafts with radar deflectors that greatly enhance their radar signature to lure ASM from their intended target. Two floats are normally launched per salvo and are considered to be effective up to three hours in sea state four. The launchers for the SLQ-49 are not normally carried unless a ship is on deployment. [Ref. 23:pp. 524-525]

3. Ship Connectivity

Modern US warships have a large range of communication assets. Through the use of various receivers, transmitters and transceivers operating in the Low Frequency (30-300 KHZ), Medium Frequency (300-3000 KHZ), High Frequency (3-30 MHZ), VHF (30-300 MHZ), UHF (300-3000 MHZ), and Super High Frequency (3-30 GHZ) bands, the ships provide connectivity to a large range of C^3 systems [Ref. 37:p. 1-3]. These include (but are not limited to):

- Fleet Broadcast (generic message traffic);
- Fleet Satellite Communications (FLTSATCOM);
- Common User Digital Information Exchange System (CUDIXS);

- Officer-in-Tactical Command Exchange System (OTCIXS);
- Tactical Intelligence Network (TACINTEL);
- Tactical Digital Information Exchange System (TADIXS);
- Tactical Data Information Link A (TADIL-A);
- Tactical Data Information Link C (TADIL-C);
- Tactical Data Information Link J (TADIL-J). [Ref. 23:p. 23]

The last three communication systems are used primarily for the data exchange between units for the Naval Tactical Data System (NTDS). The other communication systems provide various information from within and outside of the Battle Force, but generally are not integrated with a C^3 system like NTDS to distribute AAW information throughout the force. [Ref. 23:pp. 22-23]

C. LAND BASED WEAPON SYSTEMS

1. Point defense

a. *FIM-92 STINGER*

The STINGER is a shoulder-fired manportable missile which provides effective short range air defense capabilities for the Army, Navy, Marine Corps and Air Force against low level fixed-wing aircraft and helicopters. It is the weapon of choice for low altitude air defense for the U.S. and allied forces. [Ref. 38:p. 333]

The STINGER is a 35 pound supersonic fire and forget missile which replaced the REDEYE and has the ability

to engage aircraft approaching from any direction, including head-on. The missile's speed, range, maneuverability, flight tracking and countermeasures rejection capability has made it possible to counter even the most sophisticated threat aircraft. [Ref. 38:p. 333]

There are three variants of STINGER. These are the basic STINGER FIM-92A, STINGER POST (Passive Optical Seeker Technique) FIM-92B, and the STINGER RMP (Reprogrammable Microprocessor) FIM-92C.

(1) Characteristics. All three systems operate in a similar fashion. They have the following characteristics:

- all use the rolling airframe concept;
- proportional navigation;
- passive homing;
- separate launch motor;
- penetrating hit to kill warhead;
- reusable launcher grip stock;
- IFF (Identification Friend or Foe). [Ref. 30:p. 333]

The basic STINGER has an IR reticle-scan analog system which uses discrete component signal processing. The STINGER-POST uses a dual detector both IR and ultraviolet rosette-pattern image scanning to improve target detection. It also uses a digital microprocessor for signal processing. The STINGER-POST provides improved acquisition and false

target rejection by discrimination between a target and any deployed IR flares and background clutter. [Ref. 30:p. 333]

The STINGER-RMP provided additional microprocessor power and is much more resistant to countermeasures. The microprocessor can be periodically updated with new software to counter emerging threat technology instead of having to redesign the missile each time. [Ref. 30:p. 333]

(2) Specifications. The complete launcher weighs 15.7 kg. The missile has an effective range of 8000 meters with a maximum speed of Mach 2.2. The FIM-92A and FIM-92B have a less effective range of 4000 and 4500 meters respectively. The minimum effective range is 200 meters. STINGER has a maximum altitude of 3800 meters with a minimum being effectively ground level. [Ref. 39:p. 54]

2. Area defense

a. HAWK

HAWK (Homing All the Way Killer) is a semi-active radar-seeking medium range Surface to Air Missile (SAM). HAWK has been incrementally improved in various phases since its introduction to the Marine Corps in 1960 to counter an increasing threat capability. These improvements have brought about better capability, reliability and maintainability. [Ref. 40:p. 15]

Phase I which was fielded in 1981 included an Improved Continuous Wave (CW) Acquisition Radar (ICWAR),

addition of a digital Moving Target Indicator (MTI) to the Pulse Acquisition Radar (PAR), and inclusion of Army Tactical Data Link (ATDL) communications within the system. [Ref. 39:p. 275]

Phase II Product Improvement Program (PIP) upgrades commenced in 1978 and employed in 1983. Vacuum-tube circuits were replaced with modern solid state technology in the High Power Illumination (HPI) radar which greatly improved its reliability. A Tracking Adjunct System (TAS) optical tracking system for operations in an ECM environment was added to the HPI radar. The Battery Control Center (BCC) circuits were also replaced by solid state technology. [Ref. 39:p.275]

The phase III PIP upgrades started developments in 1981 and is currently in production for the U.S. armed forces. Phase III upgrades include major modifications to many of the system's major equipment. The Range Only Radar (ROR) and the Information Coordination Center (ICC) have been deleted from the system. The BCC has been replaced by the Battery Command Post (BCP). The BCP is where firing operations are monitored and controlled for a platoon. The BCP contains an Automatic Data processor (ADP), a Second Data Processor (SDP), a Tactical Display and Engagement Control Console (TDECC), IFF and communications equipment. Major electronic modification including incorporation of distributed microprocessors and enhanced computer software were made on the BCP, PCP, CWAR and HPI. [Ref. 39:p. 276]

The most noted change brought about by Phase III includes the addition of a single scan target detection capability and Low Altitude HAWK Engagement (LASHE) added to the HPI. This is done by employing a fan beam antenna which provides a wide angle, low altitude illumination pattern to allow multiple engagements against saturation raids. [Ref. 39:p. 276]

Phase III HAWK can be fielded in three configurations. These include an Assault Fire Platoon (AFP), an AFP plus and a Battery. The AFP will be composed of a CWAR, PCP, HPI and four launchers which contain three missiles each. The AFP plus is identical to the AFP except with the addition of a PAR. The Battery contains a CWAR, PAR, BCP, two HPI's and four M192 launchers. [Ref. 39:p. 276]

The CWAR provides low to medium altitude target detection in the presence of high-level ground clutter. It provides target azimuth, range and range rate. Its detection range is approximately 30 nautical miles with a max altitude of approximately 10,000 ft. [Ref. 40:p. 6]

The PAR compliments the CWAR by providing volume search coverage. The PAR provides both target azimuth and range but not altitude. Its detection range is approximately 40 nautical miles with a max altitude of 50,000 ft. [Ref. 40:p. 6]

The HPI is a three dimensional continuous wave radar which automatically tracks and illuminate targets for

engagement. It is a more direct radar using a pencil-like beam to illuminate targets. When in the LASHE mode, the HPI can operate as a wide angle illuminator for multiple low altitude, short range target engagements. The HPI also has a limited surveillance capability in a small sector when faced with a stand off jammer threat. [Ref. 40:p. 6]

(1) Advantages. HAWK provides the Marine Air Ground Task Force (MAGTF) commander with several capabilities. It provides all weather 24 hour low altitude detection at ranges in excess of 20 miles. It employs a high performance lethal missile which performs well in an ECM environment. [Ref. 40:p. 15]

(2) Disadvantages

As with all weapon systems, HAWK has its limitations. A planner must be aware of these limitations as follows:

- Mobility - HAWK is a relatively mobile system. It is out of action every time it moves to a new location. This out of action time is composed of system preparation time to move, traveling time to the new site and system emplacement time once at the new site.

- Positive identification - The Tactical Officers' (TO) ability to properly classify aircraft is limited to the capabilities of his equipment. The TO relies on IFF equipment and established procedures for identification purposes. The identification problem becomes extremely difficult when you include other factors such as the "fog of war".

- Anti-Radiation Missile (ARM) vulnerability - As with many systems that emit radiation energy, HAWK is susceptible to the ARM threat.

- Firepower - The addition of LASHE has significantly helped HAWK's previous limitation of engaging only one aircraft per HPI. LASHE, however, can only engage low flying targets within the beamwidth of the CW and in ranges within 15 KM.

- Missile signature - HAWK missiles create a highly visible backblast when fired, especially in dry, dusty areas. This cloud of smoke and dust will assist a threat pilot in locating the missile unit, as well as possibly give him reaction time to avoid missile intercept. The HAWK system also produces significant infrared, electronic, visual and audio signatures.

- Terrain/Radar masking - Terrain limits HAWK capabilities by causing radar masking. Irregularities in the terrain create areas where aircraft can fly undetected.

- Terrain slope and firmness - The terrain for HAWK employment must be fairly level and firm with adequate drainage. It must be firm enough to support the heavier pieces of HAWK equipment.

- Access - A HAWK unit requires substantial support for maintenance, repair parts, fuel and general supplies. This requires roads to and from the site, as well as within the site. If roads do not exist or unsuitable for travel, a helipad must be constructed for air delivery of support. [Ref. 40:pp. 15-16]

It is important to understand the basic capabilities of HAWK since the system is deployed worldwide in over twenty countries. It is conceivable that U.S. aviators may find themselves flying against this system by a once friendly nation that may have turned hostile. It is important to note that Iran also employs HAWK, but they are no longer supported by Raytheon. Iraq also has HAWK which were captured from Kuwait. [Ref. 40:pp. 15-16]

D. SUMMARY

The Navy and Marine Corps possess an array of modern weaponry that can be successfully employed in the conduct of AAW. Realizing the capabilities and limitations of current weapon systems allows a commander to effectively employ his assets to maximize their capabilities and minimize their limitations. The next chapter discusses proposed concepts and doctrine that may be employed as viable paradigms for future operations.

VI. FUTURE CONCEPTS AND DOCTRINE

A. FUTURE ORGANIZATION AND COMMAND

1. Space and Electronic Warfare Commander (SEWC)

The SEWC is a relatively new commander within the Composite Warfare Commander (CWC) structure. SEWC is responsible for coordinating all non-organic information coming into the Battle Force and ensuring that the information gets to the appropriate warfare commanders. Space and Electronic Warfare (SEW) brings new strategic sensors and assets not directly assigned to the Officer in Tactical Command (OTC) into the dominion of the Battle Force. The ability SEW has to provide tangible information from organic and non-organic information in an organized fashion within a capable C^3 system will greatly enhance the tactical options and perspective of the OTC and his warfare commanders. [Ref. 1:p. 8]

2. CATF, CWC, and Amphibious Doctrine

The controversy between CWC and amphibious doctrine is relatively new. One attempt at resolving the C^3 issues between CWC and amphibious doctrine is COMTHIRDFLT TACMEMO PZ1010-1-88 Composite Warfare Procedures for Amphibious Operations. The TACMEMO proponents claim current amphibious doctrine is outdated. [Ref. 41:p. 20]

The COMTHIRDFLT TACMEMO tries to provide unity of command for an amphibious operation and eliminate the need for two separate CWC organizations. [Ref. 41:p. 21]

It does this by renaming CATF as Amphibious Warfare Commander (AMWC) and placing him under the OTC's CWC organization.

> The TACMEMO eliminates the term CATF and makes the CWC responsible for the amphibious mission. CATF/CLF become warfare commanders. [Ref. 41:p. 20]

Figure 16 depicts the proposed organization.

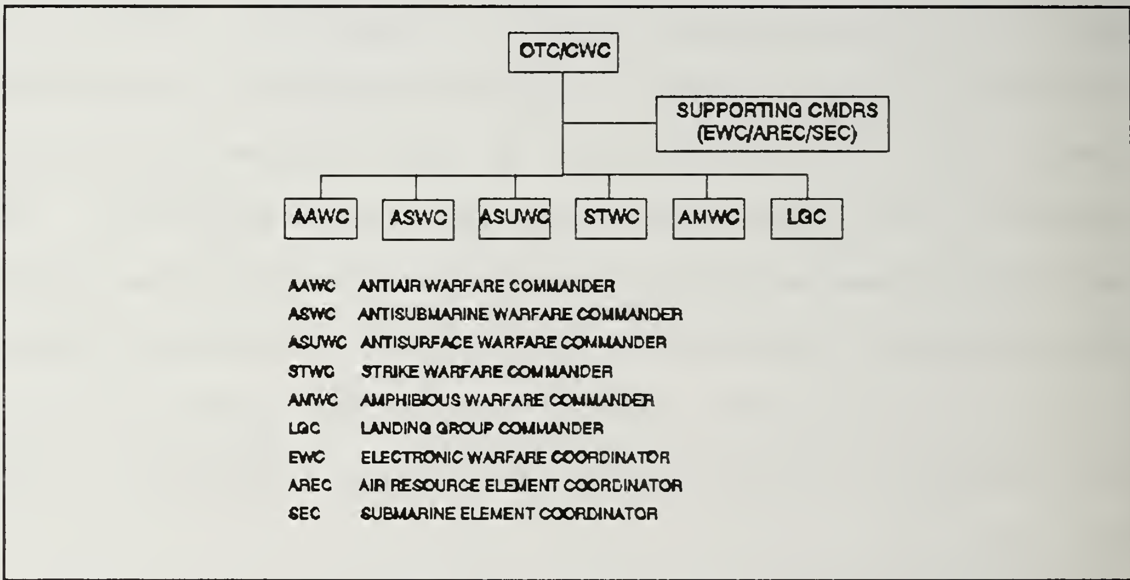


Figure 16 CWC Proposed Organization [Ref. 41:p. 21]

Proponents of the TACMEMO feel that since the primary mission of the OTC is to conduct an amphibious operation, he will be willing to provide the amphibious commander the assets he needs to accomplish the mission and will also provide protection of the ATF. [Ref. 41:p. 22]

COMTHIRDFLT TACMEMO PZ1010-1-91 attempts to reconcile the first edition with joint amphibious doctrine. The AMWC is once again denoted as CATF. The TACMEMO incorporates the term Commmander Marine Forces (COMMARFOR) taken from JOINT Pub 5-00.2. The COMMARFOR is made senior to the CLF and co-equal to the COMNAVFOR who is the OTC.

3. Amphibious Defence Zone Coordinator (ADZC)

The ADZC doctrine is proposed in Commander, Surface Warfare Development Group TACMEMO PZ3010-1-88. This TACMEMO

> "trys to integrate air defense of the Amphibious Ojective Area (AOA) into the overall battle force/fleet air defense plan. Under this concept air defense of the Amphibious Task Force (ATF) and of the Carrier Battle Group (CVBG) are treated as interconnected subsets of the same problem. [Ref. 17:p. 2-1]

This coordinator is the AAWC within the CATF's CWC command and is a Sector AAWC (SAAWC) within the OTC's CWC command. As a SAAWC, it is subordinate to the Force AAWC (FAAWC) and responsible for both the ATF's part of the AOA (seaward sector) and the beach head and landing zones (landward sector) of the AOA. As AAWC for the CATF, he is responsible for the air defense of the AOA and obtaining the required aircraft from the Air Resources Coordinator (AREC) of the Battle Force via the FAAWC to accomplish the mission and controls all Marine air assets assigned to the ATF. See Figure 17. [Ref. 17:p. 2-2]

With this concept, the ADZC is responsible for both the landward and seaward sectors of the AOA until Marine Corps

air defense C^2 assets transition ashore. Once a Tactical Air Operations Center (TAOC) is established, it becomes a SAAWC for the landward sector within the ADZC's sector of responsibility. The ADZC is still responsible to the FAAWC for the actions of the TAOC. When significant Marine Corps forces are ashore and the TACC transfers ashore, the responsibilities of ADZC shift with it. The TACC becomes the Battle Force SAAWC for the AOA and becomes the CATF AAWC for the ATF. The ship that performed the duties of ADZC normally becomes a SAAWC for the TACC/ADZC responsible for the seaward sector of the AOA. The TACC/ADZC, however, is now responsible to the FAAWC for the actions of this SAAWC. This concept attempts to centralize planning and decentralize execution. [Ref. 17:p. 4-5]

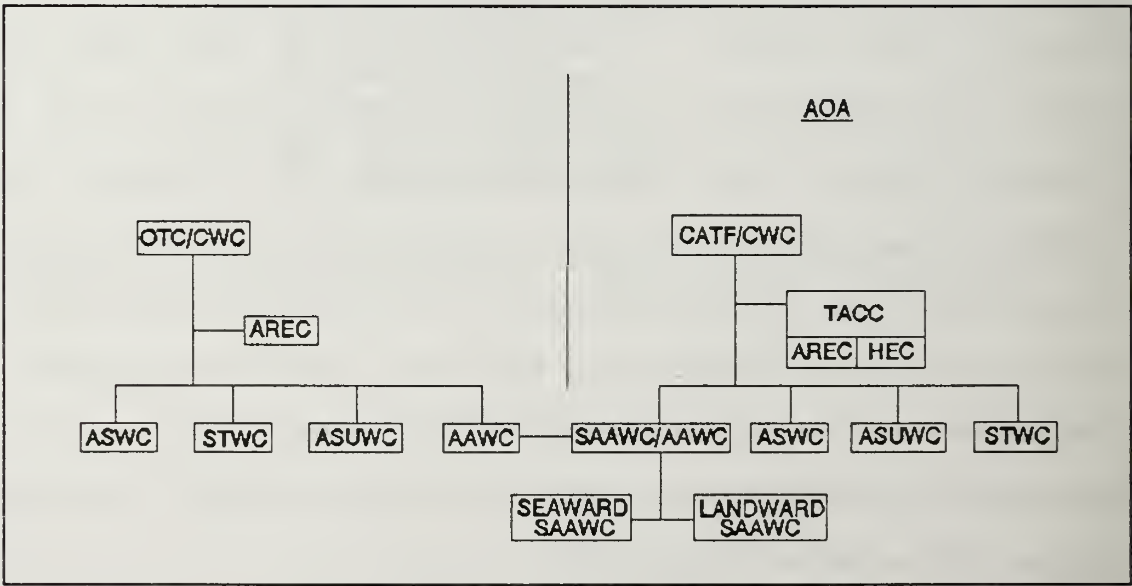


Figure 17 ADZC CWC Concept [Ref. 17:p. 5-2]

The ADZC is known as a coordinator rather than a commander because of the massive coordination he undertakes when the landings are actually being conducted. All aircraft from the carriers and the amphibious ships going into the AOA must be coordinated with the ADZC to ensure that friendly aircraft are not mistakenly engaged. [Ref. 17:p. EX-1]

B. JOINT AIR DEFENSE OPERATIONS (JADO)

1. Joint Engagement Zone (JEZ)

There are proponents who feel that the present air defense structure employing the FEZ/MEZ concept is too restrictive and does not allow for maximum exploitation by air defense weapon systems.

> This concept defines a Joint Engagement Zone as airspace of specific dimensions within which multiple air defense weapon systems (SAMs and friendly fighters) of one or more services are simultaneously employed and operated. [Ref. 42:p. H-12]

The concept relies on having systems that can provide Positive Hostile Identification (PHID). It also relies on having a fusion center that can provide the command and control necessary to effectively assign engagement of hostile air threats. [Ref. 42:p. H-12]

The purpose is to provide a more flexible system that supports both ground based and airborne air defense systems. It is designed to effectively employ air defense weaponry and reduce fratricide. [Ref. 42:p. H-12]

The JEZ concept is relatively new dating back to 1986. There have been several field tests conducted to assess the JEZ concept both in Europe and the United States. So far, no final conclusions have been made [Ref. 43]. Presently, further test and evaluation is being conducted to verify if JEZ is a viable concept for future operations.

C. SUMMARY

This chapter has reviewed the addition of a new warfare commander, the SEWC, to the CWC. This commander has the responsibility of integrating non-organic intelligence with the organic tactical data of a Battle Force and ensuring its timely distribution to the appropriate users. The ability to integrate this bountiful resource of data to the users can lead to significant increases in early warning of hostile actions against the Battle Force by enemy air actions.

Three proposed changes to amphibious doctrine have been reviewed. The proposal by COMTHIRDFLT to have the CATF integrated into the OTC's CWC as AMWC attempts to meld an integration of CVBG CWC and the CATF's CWC. Although this does integrate the two currently separate command structures, it greatly reduces the authority of the CATF and degrades his ability to accomplish the mission. The ADZC concepts attempt to integrate the two CWC structures solely in the area of AAW. This allows for the coordination of the AAW picture into a single picture while allowing the CATF to maintain his

authority and ability to accomplish the mission. The JEZ proposal tries to integrate the actual AAW battle by allowing both missile and aircraft engagements in any particular location depending which asset is better suited at any given time to conduct the engagement. This concept requires much coordination and an ability to positively identify friendly aircraft from hostile aircraft. Although this concept makes best use of the available assets, it is still to be shown that current or future C^3 systems can support it.

The following chapter reviews future C^3 systems with regard to their capabilities and limitations and discusses how they might support future paradigm changes.

VII. FUTURE C^3 SYSTEMS

A. ADVANCED COMBAT DIRECTION SYSTEM (ACDS)

The Advanced Combat Direction System (ACDS) is the successor to Naval Tactical Data System (NTDS) and the interim Combat Direction System (CDS) C^3 systems. ACDS is currently entering the fleet in two different versions (called blocks). Block 0 is limited in track capacity, surveillance range and track identification description. The system's ability to gridlock to the Data Link Reference Point (DLRP) is limited to self correlation. It is also limited in its ability to integrate Electronic Support Measure (ESM) and Antisubmarine Warfare (ASW) data. Most importantly, like its two predecessors, it is not designed to automate the decision to engage a target and does not greatly reduce a ship's reaction time. [Ref. 23:p. 81]

Compared to NTDS, Block 1 offers expanded environment coverage, automated sensor processing, four times as many track files, and much more expanded data exchange. This C^3 system allows not only for automated data exchange within a Battle Force, but also with external sources of information. ACDS Block 1 also represents a shift in paradigm for human involvement in the engagement decision. With its use of Automatic Combat System Checklists (ACSCLs), the system is

able to enact predetermined actions for very exacting situations. Once the system detects the appropriate conditions, its doctrinal processing implements the actions previously designated by the Commanding Officer (CO) or the OTC's staff for that situation. The TAO receives a display of the actions to be taken and can veto them when necessary. [Ref. 23:p. 82]

1. Facilities

ACDS is planned to be retrofitted on all aircraft carriers and TICONDEROGA class cruisers. The Arleigh Burke class destroyers and LHD class amphibious assault ships are to receive them during construction. With the reductions of the military budget during the 1990's, it is doubtful that any further retrofits to older ships will take place. [Ref. 44]

2. Equipment

The equipment within ACDS is based primarily on new and vastly improved military computers designed with 1980's technology. The new UYK-43 and UYK-44 computers replace the 1960's UYK-7 and UYK-20 computers. It is claimed that the UYK-43 is the most dependable military computer yet developed, with a Mean Time Between Failure (MTBF) of 56,000 HRS. The UYK-44 is claimed to have an MTBF of 13,000 HRS. Both computers greatly improve upon the word length, memory, speed, instructions per second, and input/output (I/O) capabilities of their predecessors. [Ref. 23:p. 40]

ACDS also allows a tremendous improvement in the display of tactical information. Automated Status Boards (ASTABs) complement the usual console graphics. The overall computer system keeps the entire ASTAB up to date continuously, including track and intelligence data. ACDS has 60 predefined formats for own ship and force data and allows for 20 user defined formats to meet any particular desires of a commander. Graphic display at consoles and at Large Screen Displays (LSDs) have been made much more detailed than those of the past and are integrated with the ACSCLs. This makes it relatively easy to comprehend the ACSCLs requirements, the tactical picture, and various boundaries that effect the tactical situation. For example, the system may be set to react to an aircraft that is outside the 12 NM limit of a country. The graphics can display the coast line of the country, the track of the aircraft, the 12 NM limit across the entire coast line, the location and time of the aircraft crossing the boundary, and a list of actions the system will take when the aircraft crosses that point. It is with this system that the paradigm of sole human involvement in the engagement decision has changed as the computer takes on part of the Threat Evaluation and Weapons Assignment (TEWA) responsibilities previously done only by the TAO and CO. This is the first system to incorporate an on-line intelligence data base that can be used for realistic TEWA. [Ref. 23:pp. 82-83]

3. Communications

Communications within the ACDS C^3 system are greatly improved over NTDS. This system allows for the inclusion of voice reports, sensor data (especially integrated ESM data), tactical data Links, and outside intelligence to be brought directly into the system [Ref. 45:pp. 10-11]. This is normally done through the Net Control Station (NECOS).

Link communications will greatly improve with the use of TADIL-J (Link 16). Link 16 is designed to replace Link 4A and complement Link 11. This is considered a jam resistant Link. Additionally, TADIL-J is capable of a ten fold increase in data throughput in its net compared to Link 11. This Link will also increase the interoperability of this C^3 system, because it is to be adopted by the Army, Air Force, Navy and Marine Corps as the common data exchange protocol. [Ref. 23:p. 19]

Although Link 16 seems to be "just what the chef ordered" in terms of a modern Link for the US military, it is not coming into operation as quickly as one might think. The lack of inter-service coordination and sky rocketing costs during a period of greatly reduced defense budgets has caused the system to be delayed and drawn out in its development and acceptance by the different armed forces. As was shown in the Desert Storm connectivity for AAW C^3 systems, TADIL-J actually added an additional Link that was not interoperable

with any of the other Links in use. See Figure 13. This was the exact opposite of one of its primary reasons for development. [Ref. 28]

B. COPERNICUS

Copernicus is a program that is designed to articulate the architecture required for a C^3 system for the 21st Century. It is attempting to accomplish several different tasks. First, it is to provide for new technologies that integrate numerous tactical and strategic sensors, facilitate tactical decision making and provide solutions to communications capacity and interoperability problems. Secondly, it is to build an organizational infrastructure and doctrine to integrate both modern war at sea and crises management in the context of Navy operations as well as Joint/Combined operations. [Ref. 1:p. 1]

Even with ACDS Block 1, Battle Forces are limited to the integration of only their organic sensors. This limits them to an environment limited to approximately 500 nm in horizontal range, 100,000 ft above the surface of the water and approximately 1 nm beneath the sea. It is envisioned that Copernicus can dramatically increase the range of the environment that its C^3 process covers with the integration of non-organic sensors (such as satellites) and other C^3 systems. It is believed that the Battle Force environment can be expanded to 5,000 miles horizontally, 23,500 miles above the

oceans and to the limits of our current and future underwater surveillance systems. [Ref. 1:p. 8]

C. ADVANCED TACTICAL AIR COMMAND CENTER (ATACC)

The ATACC is a completely new system that will replace the current TACC system. The system will no longer be housed in an inflatable container. Instead, the ATACC will be housed in an 8ft x 8ft x 20ft shelter and weigh approximately 10,000lbs. The shelter renders protection against electromagnetic interference and signal interception. It will also provide protection from biological and chemical warfare. Each shelter will accommodate five work stations and two communications processors. It will also contain display and data storage, and voice communications for both external and internal use. The ATACC provides flexibility in allowing workstations and communications distribution terminals to be relocated outside of the shelters and operated remotely if needed. [Ref. 46]

Individual shelters can be electrically connected in order to provide increased capability. The system is designed to be fielded as a suite. Two shelters linked together form a suite. Figure 18 depicts a suite configuration. A suite will support a Marine Expeditionary Brigade (MEB) size operation. Two suites linked together form a Marine Expeditionary Force (MEF) TACC. [Ref. 46]

The ATACC provides a vast improvement in computer software which allows faster and finer information processing. A

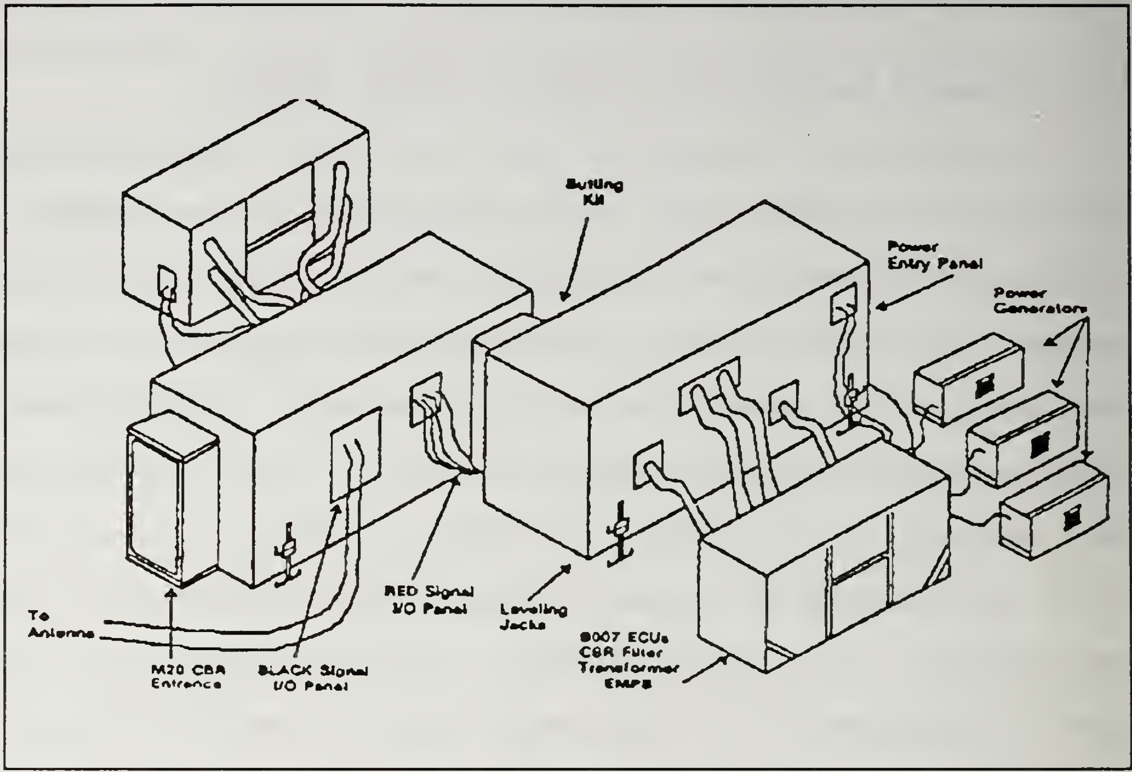


Figure 18 ATACC [Ref. 48]

database is provided which is automatically updated by messages received from TADIL-A, TADIL-B, NATO Link-1, Automatic Digital Network (AUTODIN) and Marine Tactical System (MTS). The system employs software driven menu screens on operator work stations that are easy to use. Commands, command options and command explanations are all displayed when accessed, reducing operator dependence on user manuals. Work stations are accommodated with a Voice Communications Distribution Set (VCDS). These provide operators with the ability to access radios, cryptographic equipment, telephone lines and intercommunications via Operator Control Units

(OCU's). Up to 40 radios, 16 telephone lines, four secure telephone devices and 24 intercommunications stations can be accessed through the OCU. The ATACC will provide the MAGTF commander improved mobility, capability and reliability. [Ref. 46]

D. AN/TYQ-23 TACTICAL AIR OPERATIONS MODULE (TAOM)

The TAOM is an air, land, and sea transportable automated air command and control system designed for controlling and coordinating the employment of aircraft and air defense weapons. A single fully populated TAOM is housed in an 8ft x 8ft x 20ft International Standard Organization (ISO) shelter and weighs under 17,000lbs. It is transportable via helicopter, ship, truck and fixed wing aircraft. Figure 19 is a depiction of the system including its equipment location. [Ref. 47:p. 81]

The TAOM system is a ground based system that will provide the TAOC with the hardware and software needed to fulfill the antiair warfare mission requirements of the Marine Corps. The TAOM system and associated sensors, air defense weapons and communication equipment will provide an air defense/air control capability for all levels of the MAGTF to counter the anticipated air threat and to conduct support operations. A major strength of the TAOM system is its modularity. The system is modular in design with the basic element consisting of a single TAOM. It contains four operator consoles and the

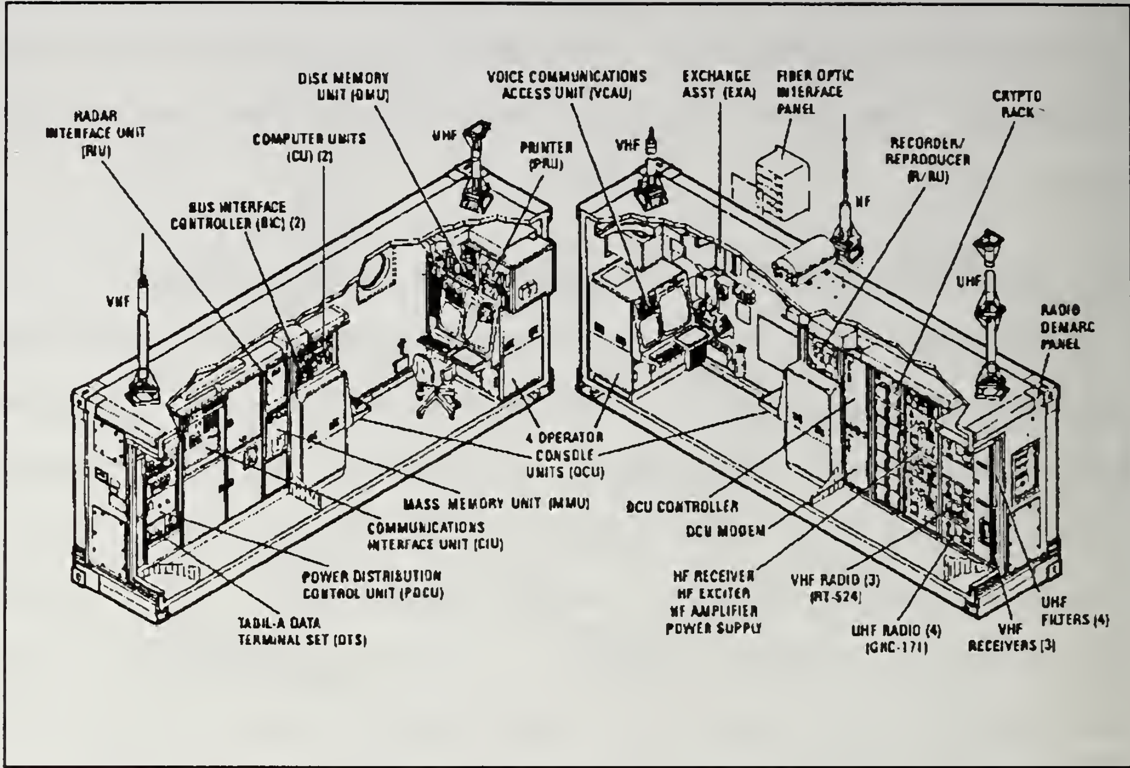


Figure 19 TAOM Expanded View [Ref. 48]

necessary communication and data link equipment to conduct limited stand alone operations. The TAOM is also designed for rapid installation requiring approximately one hour for a single TAOM to become operational. However, the TAOM system is an integrated lattice of physically separated modules connected by fiber optic cables. Ideally, the system will consist of four identical interconnected modules requiring approximately two hours to become operational. Removing one module or element from within a module from the system reduces the overall system capacity but not its capability. [Ref. 47:pp. 81-82] Figure 20 summerizes the system's capacities.

SYSTEM CAPACITIES

	NUMBER OF TAOMS				
	1	2	3	4	5
CONSOLES	4	8	12	16	20
DATA LINKS*					
TADIL-A (NET)	1	1	1	1	1
TADIL-B POINT					
ATDL-1 TO	11	22	24	24	24
LINK-1 POINT					
TADIL-C (NET)	1	1	1	1	1
TADIL J/JIMS (NET)**	1	1	1	1	1
COMM CAPABILITY					
INTERNAL					
RADIO					
UHF (HAVE QUICK)	4	8	12	16	20
VHF (SINCGARS)**	3	6	9	12	15
HF	2	4	6	8	10
TELEPHONE					
TOUCH TONE	4	8	12	16	20
DIRECT ACCESS TRUNKS	4	8	12	16	20
EXTERNAL CIRCUITS					
VOICE	12	24	36	48	60
POINT-TO-POINT DATA	12	24	36	48	60
RADAR INPUTS (TOTAL)	3	4	4	4	4
RADIO (MAX)	2	4	4	4	4
FIBER OPTICS (MAX)	3	4	4	4	4

* Use either internal radios or external data circuits.
**P3I ITEM

Figure 20 Systems Capacities [Ref. 48]

The TAOM will provide the MAGTF commander increased operational capability and versatility. It will provide him with a highly reliable, mobile and fully interoperable air command and control system with increased automation capabilities. Figure 21 provides a comparison between the TAOM and the older TAOC system. The TAOM system is a much needed and welcomed addition to the MACCS.

E. SUMMARY

This chapter has reviewed several new C^3 systems and the capabilities that they will bring to the commanders they

SYSTEM COMPARISONS - USMC

CAPABILITY/CHARACTERISTIC	TACTICAL AIR OPERATIONS CENTER	
	MTDS	TAOM
OPERATOR CONSOLES	15	16
TRACK CAPACITY (MAXIMUM)	N	2N
INTEROPERABILITY	TADIL A, B, C ATDL-1 LINK-1	TADIL A, B, C ATDL-1 LINK-1 JTIDS
AUTOMATION		
DETECTION, ACQUISITION, TRACKING	YES	YES
IDENTIFICATION	NO	YES
THREAT EVALUATION, RANKING	NO	YES
WEAPON SELECTION, ASSIGNMENT	NO	YES
TRANSPORTABILITY		
SHELTERS	16	4
CABLE PALLETS	13	4
GENERATORS	10	4
WEIGHT (LB)	196,000	120,000
AREA (FT^2)	3580	1290
C-141B LOADS	6	2

Figure 21 System Comparisons [Ref. 48]

support. ACDS provides enhanced graphics, displays for tactical data and vastly improved computer capabilities that together aid the commander and his ability to make and enact decisions.

Copernicus is a far reaching proposal for a C^3 system that would help automate the functions of the Space and Electronic Warfare Commander (SEWC) in his job of integrating non-organic intelligence with organic tactical data and its distribution throughout the Battle Force. This is a far reaching proposal that will take many years of research and development before the complete operational system is deployed.

The ATACC greatly enhances the TACC's capabilities with automation of almost all functions and greatly increases the mobility with the use of standard modular units. The TAOM replaces the AN/TYQ-2 TAOC system with state of the art automated systems. The mobility of the system is enhanced by its placement within standard modules and has the ability to link with other modules via fiber optic cables.

All of these systems are attempting to provide the commander with accurate and highly detailed information in a timely fashion which he can use to accomplish the assigned mission. The next chapter reviews weapon systems that are being studied for future use by the military. The ability of a commander to engage hostile targets at greater distances or with weapons that have increased capabilities can have a profound affect on his decision making process.

VIII. FUTURE WEAPON SYSTEMS

A. AIRBORNE WEAPON SYSTEMS

The future of naval aviation for the USN and USMC is anything but clear during the drawdown of the 1990's. This section does not attempt to predict the future. It does, however, attempt to generally describe those systems that are currently under development.

1. F-14D TOMCAT

The F-14D is a further modification of the F-14B. This version of the TOMCAT retains the engines of the F-14B, but replaces almost 60 percent of the analog avionics suite. These systems are replaced with modern, effective and easily maintained digital avionics. The AWG-9 Fire Control System (FCS) is replaced with an APG-71 that has mono-pulse angle tracking, digital scan control, target identification, raid assessment capabilities, and improved Electronic Counter Countermeasures (ECCM). Other improvements include a digital Inertial Navigation System (INS), a new computer and stores management system, and improved Cathode Ray Tube (CRT) and Heads Up Display (HUD) displays for the pilot and Radar Intercept Officer (RIO). It is planned for the F-14D to carry the Advanced Air-to-Air Missile (AAAM) if it replaces the PHOENIX. [Ref. 30:p. 91]

2. F/A-18C/D

The F/A-18C/D is a proven multi-mission aircraft. In Operation Desert Shield, the F-18 flew both carrier and land based combat air patrol and fleet defense fighter missions to suppress enemy air defenses and delivery weapons throughout Iraq. [Ref. 34] It was used in a vast array of missions effectively. On one mission during the Gulf War, F-18s successfully placed bombs on target and effectively killed two MIG's. Because of its proven performance and versatility, the U.S. has conducted studies on how to further enhance the HORNET's capabilities and performance. [Ref. 35]

There are over 20 new technological improvement programs for the F/A-18C/D but with today's budgetary constraints, it is difficult to predict which ones will be funded and eventually implemented. One of the more significant upgrades is the APG-73 radar. The development portion of this program has been funded. This radar will provide more speed and memory. It will also have provisions for follow-on improvements. The F-18 will also be fitted with an advanced Forward Looking Infrared (FLIR) for air to air operations. Other scheduled improvements include engine upgrades and reconnaissance. [Ref. 35]

3. F/A-18E/F HORNET

The F/A-18E/F originated from a study that was initiated by then Secretary of Defense Casper Weinberger in

1987. Mr. Weinberger had foreseen that future aircraft procurement such as the Advanced Tactical Fighter (ATF) would not be available in the late 1990's and early 21st century in order to combat foreseen threats of this era. He directed the Secretary of the Navy to study a derivative of the F/A-18 which would serve the needs of the Navy/USMC until advanced aircraft such as the AX or ATF enters service. The F/A-18E/F is the result of this study. [Ref. 35]

The F/A-18E is the single seat future version of tomorrow's strike fighter. The aircraft is considerably larger than its predecessor but retains the same basic shape as shown in Figure 22.

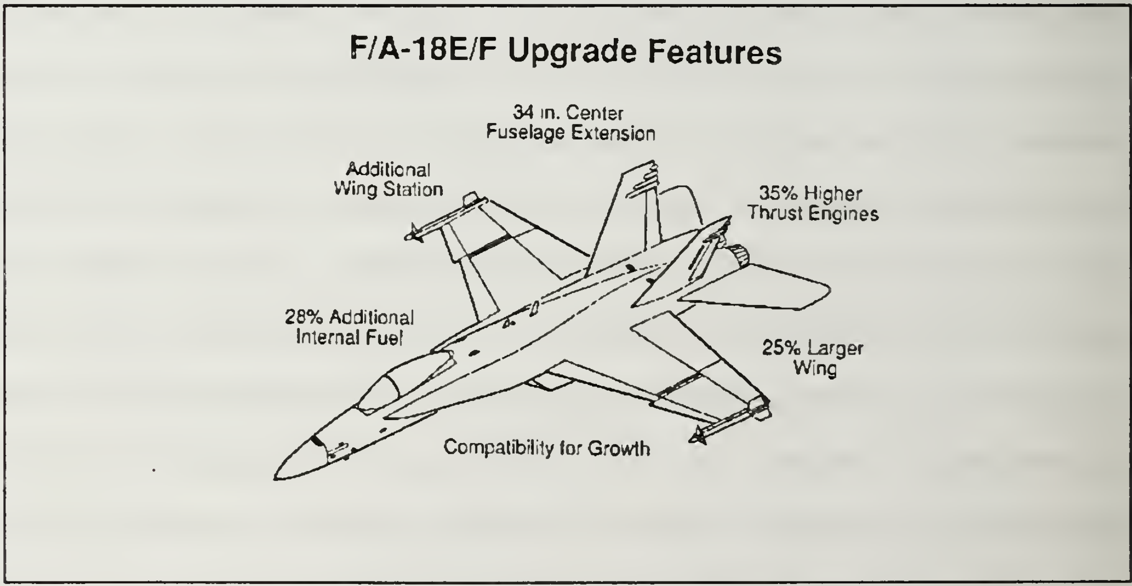


Figure 22 F18 Upgrade Features [Ref. 35]

The fuselage has been extended and the wing is 25% larger. This larger airframe allows the HORNET to increase

its internal fuel capacity by 28% which is equivalent to an additional 3,000 pounds. In addition, the F/A-18E will have the option of carrying 480 pounds of external fuel tanks which will increase its combat radius even further. This improvement is welcomed by critics who claim the F-18 has a limited on-station time. This F-18 will be fitted with a derivative of the current F404 engine which will provide a combined thrust of 44,000 pounds. The larger wing has provided for an additional two weapon stations which increases the F-18 payload and versatility. Figure 23 depicts where these two new weapon stations are located. [Ref. 35]

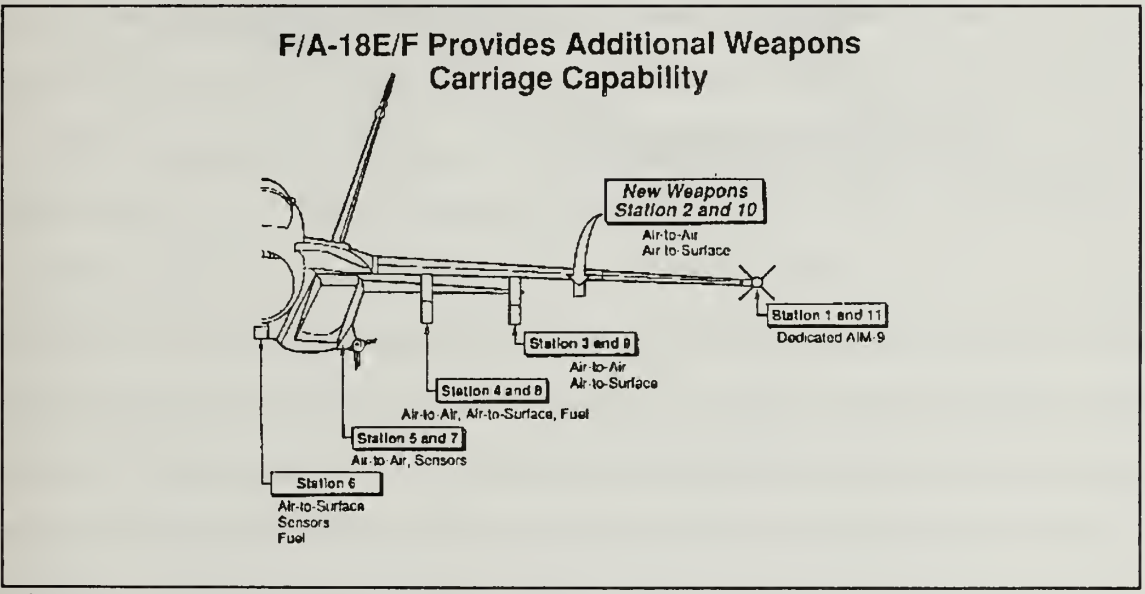
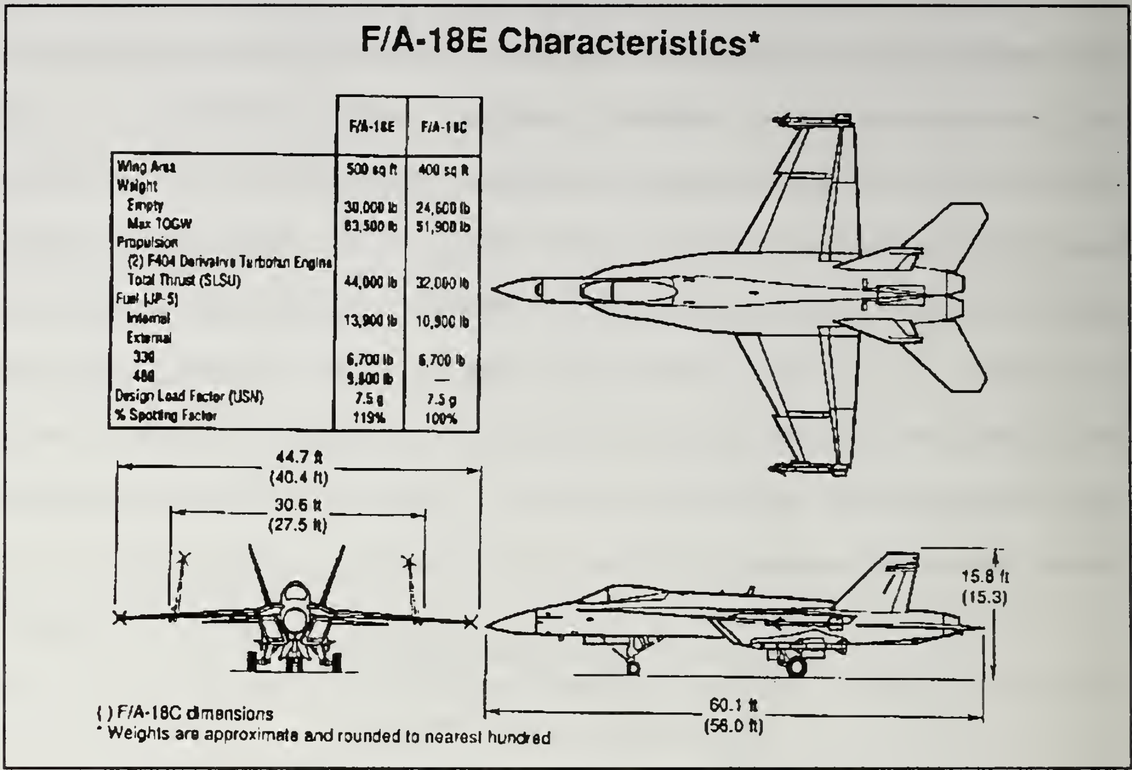


Figure 23 Weapon Station [Ref. 35]

The F/A-18E will provide tactical Navy and Marine Corp aviation with an affordable, more capable aircraft. Figure 24 is a summary of the characteristics of the F/A-18E as compared



	F/A-18E	F/A-18C
Wing Area	500 sq ft	400 sq ft
Weight		
Empty	30,000 lb	24,600 lb
Max TOGW	63,500 lb	51,900 lb
Propulsion		
(2) F404 Derivative Turbofan Engine		
Total Thrust (SLSU)	44,000 lb	32,000 lb
Fuel (JP-5)		
Internal	13,900 lb	10,900 lb
External		
330	6,700 lb	6,700 lb
480	9,800 lb	—
Design Load Factor (USN)	7.5 g	7.5 g
% Spotting Factor	119%	100%

Figure 24 F18 Comparison

to the F/A-18C. One major advantage, especially in this declining budget era is that 90% of the F/A-18E's weapon systems and avionics are essentially unchanged. This reduces cost while still providing an improved aircraft with excellent performance. The F/A-18F is the designator for the two seat version of the F/A-18E with essentially the same characteristics. [Ref. 35]

4. AV-8B HARRIER II PLUS

The AV-8B PLUS is an enhanced version of the AV-8B incorporating the Hughes all-weather APG-65 multi-mode radar system that is currently used by the F-18. The addition of

the radar system increases the operational capability of the AV-8B. The AV-8B PLUS will achieve stand-off air defense by incorporating beyond visual range guided weapons which may include SPARROW and Advanced Medium Range Air-to-Air Missile (AMRAAM) missiles. [Ref. 36]

The AV-8B PLUS will also be fitted with the F402-RR-408 engine which will provide increased thrust. These capabilities will increase the AV-8B's flexibility and operational effectiveness. [Ref. 36]

5. EA-6B ADVCAP PROWLER

This version of the PROWLER is designed around an entirely new Receiver Processor Group (RPG) and the ALQ-149 jamming system combined with an advanced version of the ALQ-99. The new system will allow the PROWLERS to respond to the improvements of threat radars over the last ten years. This includes capabilities to overcome coded pulses, spot jamming and pulse to pulse frequency agility. The ALQ-149 system will also have an enhanced capability to counter command and control communications. The new system evenly divides the work load among the three Electronic Countermeasures (ECM) officers on board so that none are underutilized. Each of their stations have been improved so that all three stations are capable of performing any task with the onboard system. [Ref. 23:p. 216]

6. Airborne Weapons

a. Advanced Air-to-Air Missile (AAAM)

The Advanced Air-to-Air Missile is designed to replace the PHOENIX missile in the Outer Air Battle (OAB). The Navy is looking for a smaller and more capable AAM than the PHOENIX. It is hoped that the AAAM will be small enough (and weigh less) so that the TOMCAT can land with eight onboard instead of its present limitation of four PHOENIX missiles. This missile will also be designed to intercept crossing and violently maneuvering targets out to 100 nm from the launching TOMCAT. Two separate teams are currently working on demonstration and validation contracts from the DOD for the AAAM. [Ref. 23:p. 416]

b. AIM-120A AMRAAM

The Advance Medium Range Air-to-Air Missile (AMRAAM) is intended to replace the SPARROW missile. The most advanced feature of this missile is that it is a fire and forget missile. It is essentially a mini-PHOENIX. The AMRAAM is launched towards the predicted intercept point of a designated target. Data link information allows the missile to adjust its course to overcome maneuvers by the target. When the missile is near enough to the target it activates an X-band pulse-doppler seeker to home on the target by itself. To increase its range and kinematic energy it is powered by a boost-sustain motor vice the boost-glide motor of the SPARROW.

The AIM-120A allows a pilot to engage multiple targets at one time. [Ref. 23:p. 417]

B. SEA-BASED WEAPON SYSTEMS

1. New Threat Upgrade (NTU)

The NTU modification is an extremely important system that is being added to almost all large AAW surface combatants that are not AEGIS equipped. This system greatly increases the sensor, computer and weapon systems capabilities to engage Antiship Missiles (ASMs) and aircraft into the century. [Ref. 33:p. 49]

a. Sensors

The normal suite of SPS-48 and SPS-49 air search radars are maintained, however, they have been greatly improved upon. The SPS-48E is the standard version for NTU. This version doubles the effective radiated power, reduces sidelobes to increase ECCM, increases receiver sensitivity, and extends maximum angle coverage to 65 degrees above the ship. Additionally, reliability and ease of operation have been vastly improved. Overall, part count has been reduced by 50 percent. [Ref. 23:pp. 332-333]

The SPS-49(V)5, likewise, has been much improved. This version employs digital pulse-doppler processing to reject clutter, has coherent sidelobe canceling and upspotting capability to increase ECCM, and increased peak power out.

The radar's reliability and ease of operation have also been improved. [Ref. 23:p. 333-334]

In addition to the radar improvements, a new system has been installed with NTU that allows for the two separate radars to operate together as if they were a single radar. The SYS-2 Integrated Automatic Detection-and Tracking (IADT) system automatically receives the data from both radars, compares them and then automatically correlates all mutual tracks to produce a single air picture. Additionally, it automatically feeds this data to the Combat Direction System (CDS) for weapons control and Naval Tactical Data System (NTDS) Link 11 without human intervention. This allows for the near elimination of false or dual tracks and manual entry errors and delays to Link 11. [Ref. 33:p. 54]

Although the actual range of detection has not increased with NTU, the probability of detection and continued tracking of multiple air targets in an extremely hostile jamming and chaff environment have increased greatly.

b. Weapons

All of the above improvements are nice, but do not help much if you do not have a weapon that can engage a target at these long ranges. The SM-2 BLK II series of Surface-to-Air Missiles (SAMs) are designed to do just that. With their improved software and booster, the Extended Range (ER) version can engage targets out to 115 nm and up to 100,000 ft.

Additionally, for larger bomber-size targets, they are able to engage, under certain conditions, up to the range limits of the fire control radars. Likewise, the MR missiles, can engage out to 90 nm and up to 100,000 ft or for bomber-size targets, under certain conditions, out to the range limits of the fire control radar. [Ref. 23:p. 404]

2. Ship Weapons

a. Surface-to-Air Missiles (SAMs)

(1) Standard Missile Block III and IV. The SM continues to be upgraded to increase its performance in the long range air battle as well as the low altitude intercept. As mentioned previously, the only major difference between the ER and MR version of this missile are the range limitations imposed by the different boosters. The block modifications for either type have the same capabilities for intercepting targets. The BLK III introduces an improved low altitude fuse for intercepting targets just above the water. Missiles with BLK IIIA contain a new warhead and further refinements for low altitude intercepts. The BLK IIIB incorporates an additional Infrared (IR) seeker to improve target discrimination over the water and in jamming and chaff environments. [Ref. 23:p. 404]

SM-2 BLK IV has been designed specifically for vertical launching. This version adds a short finless booster to the normal SM-2MR missile so that an AEGIS Vertical Launch System (VLS) ship can obtain engagements closer to the ER

ranges listed above. These missiles are also unofficially know as SM-2 AEGIS ER. [Ref. 23:p. 404]

(2) RIM-116A RAM. The Rolling Airframe Missile (RAM) is a new point defense missile that may replace or compliment both the SEA SPARROW and PHALANX. It is designed to be a fire and forget weapon. It can launch on either an IR signature, or it can home on the emission of an active radar, much like an Antiradiation Missile (ARM). RAM combines a SIDEWINDER motor, warhead, and fuse, a STINGER infrared seeker, and a two antenna Radar Frequency (RF) seeker. Several different launchers are being considered for the RAM. A RAM II version with increased sensitivity for both IR and RF homing is under development. [Ref. 23:pp. 400-401]

b. Guns

(1) 20 MM MK15 CIWS BLK 1. This version of the PHALANX has many improvements over the original version. It carries 50 percent more ready service ammunition, increases search-elevation coverage, has better reliability and ease of operation, and larger velocity engagement window of in bound targets. BLK 1, Baseline 1 adds pneumatic gun drive which increases firing rate to 4,500 rounds per minute. MK15 CIWS BLK 2 is currently under development and will most likely have an increased caliber gun. This development is also known as "CIWS 2000". [Ref. 23:p. 468]

c. Countermeasures

(1) SLQ-32(V)4 and 5. The SLQ(V)4 is to replace the SLQ-17 aboard aircraft carriers. (V)4 employs fiber optics to reduce interference from external sources. This system also has a digital memory for faster threat evaluation. It uses two computers to control the entire system. Each computer is located near a transmitter/receiver group. [Ref. 23:pp. 530-531]

d. Research and Development

There are many "black" programs underway to develop new systems. They range from chemical lasers and directed energy weapons to electro-magnetic guns. Each of these programs are under critical review with the reduced DOD budgets for the 1990's. It very likely that few will survive since most third world nations do not have a threat that requires their immediate use.

C. LAND BASED WEAPON SYSTEMS

1. Point Defense

a. Light Armored Vehicle Air Defense (LAV-AD)

The U.S. Marine Corps presently does not have a mobile air defense weapon system and relies on the man portable STINGER and Improved HAWK (I-HAWK) Surface to Air Missile (SAM) to fulfill its air defense requirements. The primary role of the LAV-AD is to engage helicopter and fixed-winged aircraft with a secondary role of engaging ground

targets using a cannon. The HYDRA-70 rockets which were intended for engaging ground targets have been deleted from the LAV-AD requirements. [Ref. 39:p. 98]

Prior to deciding on an air defense system, the Marine Corps evaluated five possible solutions to meet the LAV-AD requirements. These are as follows:

1. A base line system consisting of a standard LAV-AD equipped with the McDonnell Douglas helicopters 25 MM chain gun and carrying two man stinger SAM teams.

2. The basic LAV-25 modified to carry STINGER SAM pods and equipped with a narrow field of view FLIR system.

3. LAV with new turret mounting for British Aerospace Rapier SAMs and a millimeter wave radar.

4. LAV with Oerlikon-Buhrle Air Defense Anti-Tank System (ADATS) which at the time had not been adopted by the U.S. Army.

5. LAV with General Electric GAU-12/U 25MM gatling gun, STINGERS and HYDRA-70 rockets with growth potential. [Ref. 39:p. 98]

The U.S. Army Tank Automotive Command accepted two bids for an air defense version of the LAV. One bid was from FMC Corporation and the other from General Electric Company.

(1) FMC LAV-AD. FMC version of the LAV will consist of a two-man power-operated turret armed with four General Dynamics SITNGER SAMs, and a McDonnell Douglas Helicopters M242 25 mm chain gun. The electric turret will be built by Cadillac Gage which can traverse a full 360 degrees and elevate from -8 to +65 degrees. The U.S. Marine Corps

presently has the M242 in service installed on the LAV-25. The fire control system will be mounted on the rear of the turret which houses the primary sight with two fields of view, Forward Looking Infrared (FLIR) and television. The magnification of the FLIR is 2.67x and 8x. The magnification of the day TV is 4x and 12x. The fire control system will include a multi-mode automatic tracker and a laser range finder with two video displays. Two backup sights will be boresighted to the weapons. The total weapon loadout will consist of 12 STINGER missiles, 16 smoke grenades and 990 25 mm rounds. The vehicle will also be fitted with a land navigation system. [Ref. 39:p. 99]

(2) General Electric LAV-AD. The General Electric system is based on the Blazer two-man power-operated turret which was developed as a private venture by the Armament Systems department of GE Aerospace. The Blazer will be armed with the GA-12/U 25 mm gatling gun and four STINGER SAMs. The GA-12/U 25 mm gatling gun is already in service used by the U.S. Marine Corps McDonnell Douglas AV-8B Harrier. This gun, as opposed to the M242, has five barrels and can shoot at a firing rate of 1800 rounds per minute. Each vehicle will also be fitted with a 7.62mm machine gun and two pods of four electrically operated smoke dischargers. [Ref. 39:p. 99]

The combat weight of the LAV-AD, which includes the crew and ammunition, will be approximately

29,000lbs. The LAV-AD provides logistics advantages since it can be transported via C-130, C-141, C-5 and the CH-53E helicopter. The turret is capable of traversing a full 360 degrees with powered weapon elevation from -8 to +65 degrees. The LAV-AD uses Forward Looking Infrared (FLIR) integrated with a TV for primary target engagement. The GE LAV-AD will have a crew of three which is composed of a driver, gunner and commander and will be able to fire on the move. Although not a present requirement by the Marine Corps, the GE LAV-AD will keep the HYDRA-70 rockets as an option. [Ref. 39:p. 99]

2. Area Defense

a. Improved HAWK (IHAWK)

There are several programs in progress which are trying to further develop and exploit the HAWK system. The primary upgrade program for the HAWK system is the HAWK Mobility, Survivability and Enhancement (HMSE) program. The program goal is essentially to improve the system's mobility. This will include a reduced emplacement time and march order time. [Ref. 39:p. 277]

In addition, there is a HAWK PIP phase IV and V designed to further enhance HAWK's capability well into the 22nd century. With the defense cut backs, it is difficult to predict what follow on improvements will actually occur.

b. PATRIOT

The PATRIOT is an effective combat proven system. Although HAWK presently provides adequate medium range air defense, the PATRIOT system should be considered as a future weapons system that can be jointly procured in order to reduce cost. PATRIOT can either replace or augment HAWK, especially in the medium to high altitude regime.

D. SUMMARY

This chapter has reviewed the weapon systems that are currently being studied for military use. These weapon systems can lead to a change in doctrine as they embrace new technologies that allow engagement of hostile aircraft in ways that before were only imagined. A prime example of this is the AMRAAM. The ability to use a long range fire and forget AAM could lead to a drastic change in the way that aircraft target and engage enemy aircraft. This in turn can lead to a change in the way a commander makes his decisions and the paradigm that he is working in.

The following chapter brings together the findings of the various chapters of the thesis. These findings are used to make recommendations for future paradigms in the conduct of amphibious operations.

IX. SUMMARY AND CONCLUSIONS

A. SUMMARY

The success of an amphibious operation depends on the smooth functioning of an array of warfare specialties.

> (It) depends on the orchestrated application of virtually the entire array of naval power... (including) antiair and missile warfare, close air support, defense against missile boats, naval gunfire support and mine countermeasures. [Ref. 49 p. 394]

A problem exists in that senior naval tacticians do not agree on how to best command this array of naval power during amphibious operations. For over a decade, the Navy has employed the Command and Control (C^2) concept of Composite Warfare Commander (CWC). This concept is designed to ensure task force survivability in a multi-threat environment which involves reduced reaction times. [Ref. 41 p. 3-4]

Amphibious doctrine has evolved from lessons learned from two world wars and the Korean War. Current amphibious doctrine has incorporated the CWC concept. Commander Amphibious Task Force (CATF) has his own CWC that works directly for him. There have been numerous Non-combatant Evacuation Operations (NEOs) conducted at the Marine Expeditionary Unit (MEU) level that have been well executed using the current amphibious doctrine.

These seem to be successful because all C^3 within the Amphibious Objective Area (AOA) were integrated within the CATF's CWC. However, once an operation goes beyond the size of the standard deployed MEU, C^3 problems grow greatly, especially for Antiair Warfare (AAW). Current Navy doctrine calls for the establishment of two separate CWCs: one for the Carrier Battle Group (CVBG), which would normally also have the overall Officer-in-Tactical Command (OTC) embarked, and one for the CATF. [Ref. 13:pp. 9-10 - 9-12]

Protection of the CVBG has seemingly taken precedence over the protection of an Amphibious Task Force (ATF). This leads to an inappropriate division of available assets for the protection of both the CVBG and the ATF.

As long as CATF is designated by an Initiating Directive, he has the authority he needs to obtain the supporting assets required from the CVBG to accomplish the mission and tactical control of all friendly assets within the AOA. If a CATF is not designated, it can lead to confusing C^2 during the operation. For example, during Operation URGENT FURY,

> ...there was no Initiating Directive, CATF was never designated, an AOA was not established, and the amphibious force commander (CAPT Erie) was not given tactical command of the forces required to effectively accomplish his mission. For instance, CAPT Erie never had tactical command of the naval gunfire ships and the supporting commander could reassign those ships to another mission at any time. This situation was of particular significance to the Army and Marine forces ashore whose lives and mission depend heavily on receiving fire support immediately upon request. [Ref. 41:pp. 12-13]

At the heart of a coordinated AAW battle is the Tactical Data Information Link (TADIL). The various TADILs provide the means to share tactical data between the various C^3 systems. Unfortunately, not all C^3 systems can operate on all TADILs or exchange data between them. This may lead to a problem of interoperability between the assets of a Battle Force and the accomplishment of the mission. It also leads to a very complicated effort to maintain an integrated AAW picture as depicted in Figure 13. Currently, there are efforts to combine the functions of the various existing TADILs into a single datalink called TADIL-J. This proposed datalink is be used by the U.S. Armed Forces.

C^3 systems and TADILs aid a commander in effectively employing his weapons systems. The Navy and Marine Corps possess an array of modern weaponry. They are continuously upgrading and modernizing these systems to meet the expected threat. This provides the commander flexibility in his decision making to counter the threat and accomplish the mission. The advent of new weaponry can lead to new capabilities and tactics that support a change in doctrine. Currently, there is no set doctrine for the AMRAAM and its long range fire and forget capabilities. The proposal of the Joint Engagement Zone (JEZ) concept is an example of an attempt to change tactics to exploit the capability of modern weapon systems.

The lack of particular weapon systems must also be taken into account by a commander. The Marine Corp has no medium-to-high altitude Surface to Air Missile (SAM) capability. It currently relies on either aviation assets or offshore Navy ships to provide AAW protection in this region. If neither of these assets are immediately available, a commander may suddenly find himself in a dire situation.

Due to advances in C^3 and weapon systems, senior naval tacticians have proposed changes in the paradigms for amphibious operations. There are currently two proposals to modify the amphibious doctrine in different ways. Both proposals are described in Chapter VI and recommendations for them are discussed in the conclusions section.

B. CONCLUSIONS

1. CATF, CWC, and Amphibious Doctrine

> TACMEMOs and subsequent doctrine that are written solely on the basis of the seniority of the players in peacetime are doomed to failure; either of themselves or the forces attempting to use them in a war. [Ref. 50:p. 2]

Commander Third Fleet (COMTHIRDFLT) TACMEMO PZ1010-1-88 had several major differences with doctrinal issues discussed in Joint Pub 3-02 that are considered indispensable to the success of an amphibious operation. Doctrinal issues such as CATF and Commander Landing Force (CLF) being collocated are essential for the success of an amphibious operation. COMTHIRDFLT TACMEMO PZ1010-1-88/91, as proposed,

is not workable. As quoted from an East Coast amphibious group commander's point paper, the TACMEMO is unworkable for the following reasons:

> a. The TACMEMO is contrary to the COMSECONDFLT Fighting Instruction which provides for CATF as a battle group commander and CWC in the AOA.
>
> b. CATF should be responsible for his own defense and not subject to the priorities of another flag officer.
>
> c. CATF collocated with CLF is in the best position to direct the employment of all forces assigned and must have instantaneous response from the support force [Ref. 50:p. 2-4]

Eliminating the term CATF and the authority invested in him via the Initiating Directive places amphibious warfare in a secondary role in situations where the primary mission of the naval force is to establish a landing force ashore in a hostile or potentially hostile environment. This notion was opposed by both amphibious and CVBG commanders. [Ref. 41:p. 3-4]

The TACMEMO inserts another level of command that is not necessary.

> The establishment of an OTC between the amphibious warfare commander (CATF) and the common superior (FLTCDR) inserts an unnecessary level of command between the officer responsible for accomplishing the mission and the fleet commander. [Ref. 50:p. 2]

Amphibious and AAW doctrine has evolved into its present form from many years of lessons learned. Doctrine does not attempt to prescribe how to conduct operations. It provides a foundation based on time-proven principles and

ideas from many professionals who used the doctrine in past campaigns. [Ref. 41:p. 14]

It is recommended that the proposed doctrinal changes in this TACMEMO not be adopted.

2. Amphibious Defense Zone Coordinator (ADZC)

The ADZC paradigm put forth in Commander Surface Warfare Development Group TACMEMO PZ 3010-1-88 will soon be upgraded to TACNOTE PZ 3010-1-92 [Ref. 51]. The object of this doctrine is to combine the overall AAW picture of the Carrier Battle Group (CVBG) and the Amphibious Task Force (ATF) such that the air defense of each is a subset of an overall coordinated AAW problem instead of the current doctrine of a separate air defense problem for each. This proposal does not alter the overall authority of the CATF, and provides a much more comprehensive defense of the AOA. Additionally, it provides a more direct avenue to request air assets from the Air Resource Element Coordinator (AREC) to assist in the defense in the AOA. Unfortunately, this TACMEMO does not include the integration of the Joint Force Air Component Commander (JFACC) within the overall AAW coordination effort.

It is recommended that this concept be tested using a series of games and simulations to test its validity. Upon successful completion of the games, the concept should be tested in an exercise of enough size and scope, especially

with regard to the integration of a JFACC and the AREC, to determine if the proposed change in paradigm is viable.

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